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Improving the Virtual Learning Development Processes Using XML Standards

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Distributed learning environments and contcnt often lack a common basis for the cxchange of learning materials. This delays, or even hinders, both innovation and delivery of learning technology. Standards for platforms and authoring may provide a way tn improve internperability and coopcrativc development. This article provides an XML-based apprnach tn this problem crcaicd by the IMS Global Learning Consortium.

KEY**WORDS:** Distributed learning environments, exchange of learning materials. IMS Global Learning Consortium, XML, XML-based approach.

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I. INTRODUCTION

In the meantime, the digitalization of education materials has been advancing for some years and its necessity has been ubiquitously propagated. In fact, systems and materials for virtual teaching have been developed by corporations, universities and government agencies around the world since then. Aside from that, one can find a large number of more or less systematically constructed and maintained content on the Internet. For many involved in education the use of these resources became an integral part of their daily work routine.

Potential users of educational contents, however, whether they be students or teachers, often see themselves, in using the new technology, confronted with significant obstacles: every virtual learning environment follows its own understanding of the "correct" usability; the materials are often adapted to fit the lesson plans and needs of the respective providers and don't cover the requirements of third parties; file formats, such as PowerPoint and Flash applications, make it difficult to directly access parts of more extensive contents pertaining to one's own purposes. The list goes on.

II. TEACHING UNITS USING THE BUILDING BLOCK PRINCIPLE

If one considers these aspects together with the substantially higher effort in creating a virtual lecture hour, in comparison to conventional lectures, the demand for the reusability of digital teaching units, for the use of synergy and coupling effects, and for the disaggregation of complexly structured virtual lectures and seminars is not only understandable but also justified. The goal would be the efficient and effective compilation of digital teaching units using the building block principle.

Are such building blocks conceivable and how should they be constructed? An important feature would be file formats, which —if possible, platform independent— are not subject to limitations such as the above mentioned PowerPoint and Flash formats and support built-in mechanisms for structuring the contents, or rather the direct access to parts of documents. Moreover, information for interactive contents, such as exercises and simulations, should be codable in the document itself. Standards in the form of "templates", which take all criteria for the realization regarding content and didactic into consideration, are desirable for the support of the interchangeability of the materials and their efficient production. The same goes for problems with character sets which should especially be considered regarding foreign language training material. Application software for the creation and delivery of virtual teaching and learning units should again optimally support and transparently implement the developmental process.

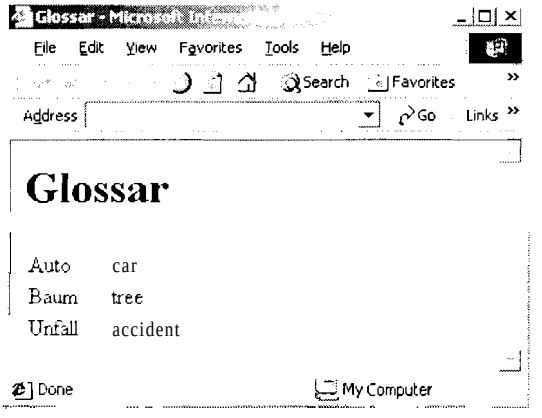
III. FLEXIBILITY AND PLATFORM INDEPENDENCE THKOUGH XML

For a few years now the extensible Markup Language (XML) has prcsented itself as a solution for a llcsible and platform indcpcndcnt production of digitized material. XML was introduced in 1996 with the goal of replacing HTML on a long-term basis as the *Lingua Franca* of the Web. HTML is a less flexible mix of'dircctives for thc structuring and prcscntation of docurnents — a large part of the HTML-elements, such as <H1>, <H2> and <EM>, serve to control the layout. In contrast to this, XML has some signiticant advantagcs: separation of structure, contcnt and layout. the determination of markup clements —more specifically, its own Document Type Definition (DTD)—, mechanisms for the direct access to parts of the document, Unicode support and more.

The differenee between HTML and XML becomes clear in an example from a simple glossary. The corresponding HTML-code (without header) could look like the following:

```
<body>

<h1>Glossar</h1>
      <p>
            <table>
                  <tr>
                        <td>Auto</td>
                        <td>car</td>
                  </tr>

                  <tr>
                        <td>Baum</td>
                        <td>tree</td>
                  </tr>

                  <tr>
                        <td>Unfall</td>
                        <td>accident</td>
                  </tr>
            </table>
      </p>

</body>
```


A Web-Browser displays these lines as in the following picture:



While only the determined directives are valid in the HTML-document, XML enables the insertion of its own markup elements such as <Glossary>, <Entry>, <German>, <English>, omitting any layout information and, moreover, — in contrast to the abstract HTML-elements <tr> (table row) and <td> (table data) — allows conclusions of the information provided. And the glossary as an XML-Document (without Header) looks like this:

```
<Glossar>

<Titel>Glossar</Titel>

<Eintrag Id="1">
      <Deutsch>Unfall</Deutsch>
      <Englisch>accident</Englisch>
</Eintrag>

<Eintrag Id="2">
      <Deutsch>Auto</Deutsch>
      <Englisch>car</Englisch>
</Eintrag>

<Eintrag Id="3">
      <Deutsch>Baum</Deutsch>
      <Englisch>tree</Englisch>
</Eintrag>

</Glossar>
```


Tlic eXtensible Stylcslicct Language (XSL) is used for displaying XML docunicnts. It provides tlie functions and rulcs for tlic prcscntation of tlie XML elements. Not only can these mechanisms process XML documents for prcsentatioti iti a Wcb browscr as in tlic abovc example, but also for tlic output in many otlier forniats such as tlie Portable Docunicnt Format (PDF). Morcovcr. tlic possibility exists, with thc help of tlic XSL Stylesheets, to directly display parts of'docuiiicnts. while HTML-files niust be completely loaded.

IV. STANDARDIZATION EFFORTS

The advantages, in particular which XML has ovcr HTML in processing large nunibcrs ofsiniilar documents, cannot only be uscd for glossaries, but also for intcractive exercises, regional studics. grammar, etc..

Tlic strength of the approacli could, Iiowcvcr, turn itself around if those involved in the production of teaching iiiatcrials create "isolated solutions" in thc form of thcir own XML document typc definitions. Tlic cffort in adjusting foreigti docunients to inscrt in one's own environment is significant aiid. iii terms of tlic mutual use of resources as in the contcxt of virtual universities, uneconomical.

Given these problems, several organizations, such as the IEEE Learning Teclinology Standardisation Committee, the Advanced Distributed Learning (ADL) Initiative, the Aviation Industry CBT Committee (AICC) aiid tlie ISO/IEC JTC1 SC36 Learning Tcchnology, have gone to trouble ol'gciting standardizations in tlie area of virtual lcarning in thc past. Thc IMS Global Learning Consortium, Inc. (IMS) is pursuing an additional, more promising approach. She members of the non-prolit organization include, among others, a scrics of wcll-known companies, universities, and govcrnmcnt agencies, siicli as Apple. IBM, Microsoft, Oracle, Massachusetts Institute of Technology (MIT), and tlie Open Universiteit in tlic Nctlicrlands. IMS is speeding up the development aiid proinotion ofopen XML-based specifications, wliich should specifically support activities in tlie field of distributed on-line learning, such as, Sor example, finding aiid using learning materials or tlic assessment of thc progrcss and pcrforniance in one's studics.

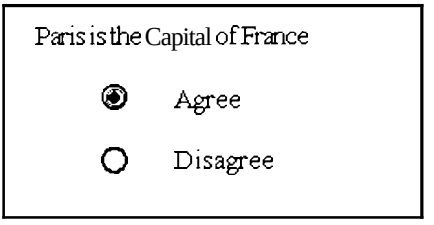
- The *Question & Test Interoperability Specification* (QTI) describes a basic structure Sor tlic representation of Item and Assessment. Tlic specification enables the exchange of this test, assessment and results data bctween Learning Management Systems, as well as content authors and, content librarics and collections. It is cxtcnsible and customizable to allow for tlic immediate adoption, cvcn in specialized or proprietary systcnis.
- Tlic *IMS Content Packaging Specification* provides tlic functionality to describe and package learning iiiatcrials, such as an individual coursc or a collection ofcourses, into

interoperable, distributable packages. Content Packaging addresses the description, structure, and location of online learning materials and the definition of some particular content types. The Content Packaging Specification is aimed primarily at content producers, learning management system vendors, computing platform vendors, and learning service providers. Learning materials described and packaged using the IMS Content Packaging XML format should be interoperable with any tool that supports the Specification. Content creators can develop and distribute material knowing that it can be delivered on any compliant system.

- The *IMS Learning Resource Meta-data Specification* was developed to counteract the fact that the now large number of software tools for the creation of learning materials lacks a common mechanism which finds and uses the materials. A meta-data specification ensures more efficient processes in finding and using resources, in which a structure of definable, descriptive labels would be offered, which would describe, or rather, catalogue the learning resources.
- The *IMS Learner Information Package Specification* is a collection of information about learners or producers of learning contents. The specification aims at the interoperability of Internet-based learning information systems with other systems which support the Internet learning environments. The goal of the specification is to define a number of packages which can be used to exchange data with learning information servers corresponding to the IMS-Specification.
- The *IMS Reusable Competency Definition Specification* plots out an information model to describe, to reference and to exchange competency definitions, primarily within the context of on-line and distributed learning. In this specification the word "competency" is used in a very general sense and incorporates skills, knowledge, assignments and learning results. This specification offers the functionality to formally present, independent of its use in a certain context, key characteristics of competency and to enable the interoperability among learning systems which delivers competency information.
- The objective of the *IMS Enterprise Specification* is to define a standardized set of structures that can be used to exchange data between different systems and to guarantee an integration, as optimal as possible, of training management systems in existing IT infrastructures.

V. APPLICATIONS

A simple example from the Question & Test Interoperability Specification gives the first impression of possible realizations of the specification. A true/false question without processing could be represented as an interactive exercise as follows:



The corresponding formulation in QTI-XML shows the following code excerpt:

```
1    questestinterop
       qticomment
3                This is a simple True/False multiple-choice example using QTI V1.0 or V1.1.
4    Anm.  ›     The rendering is a standard radio button style.
5                No response processing is incorporated.
6      /qticomment
       item ident="IMS_V01_1_BasicExample001"
8        presentation label="BasicExample001"
9          material
10   Frage →          mattext>Paris is the Capital of France</mattext
11         /material
12   Eine Antwort →   response_lid ident="TF01" rcardinality="Single" rtiming="No">
13   Darstellungsformat  render_choice>
14                      response_label ident="T"
15   Wahr →                 material><mattext>Agree</mattext></material>
16                      /response_label>
17                      response_label ident="F">
18   Falsch →               material><mattext>Disagree</mattext></material>
19                      /response_label
20                   /render_choice>
21         /response_lid>
22       /presentation>
23     /item>
24   /questestinterop>
```


Tlie QTI code can be completely transparent for the user. Applications are now available (see, among others, http://www.imsproject.org/direct/jetproducts.cmf (10.29.2001)) which iniplement tlie specification in the form of Windows-, Java-, or HTML-based applications and enable learners and authors to work in the familiar Look and Feel. Nonetheless, the products of differcnt manufacturers can exchange test materials among themselves, since the data, as in the above exaniple, are available in QTI-XML format. QTI distinguishes between basic response and render types. from which a total of twelve types of answers can be derived, which, in part, are again variable, or rather, combinable.

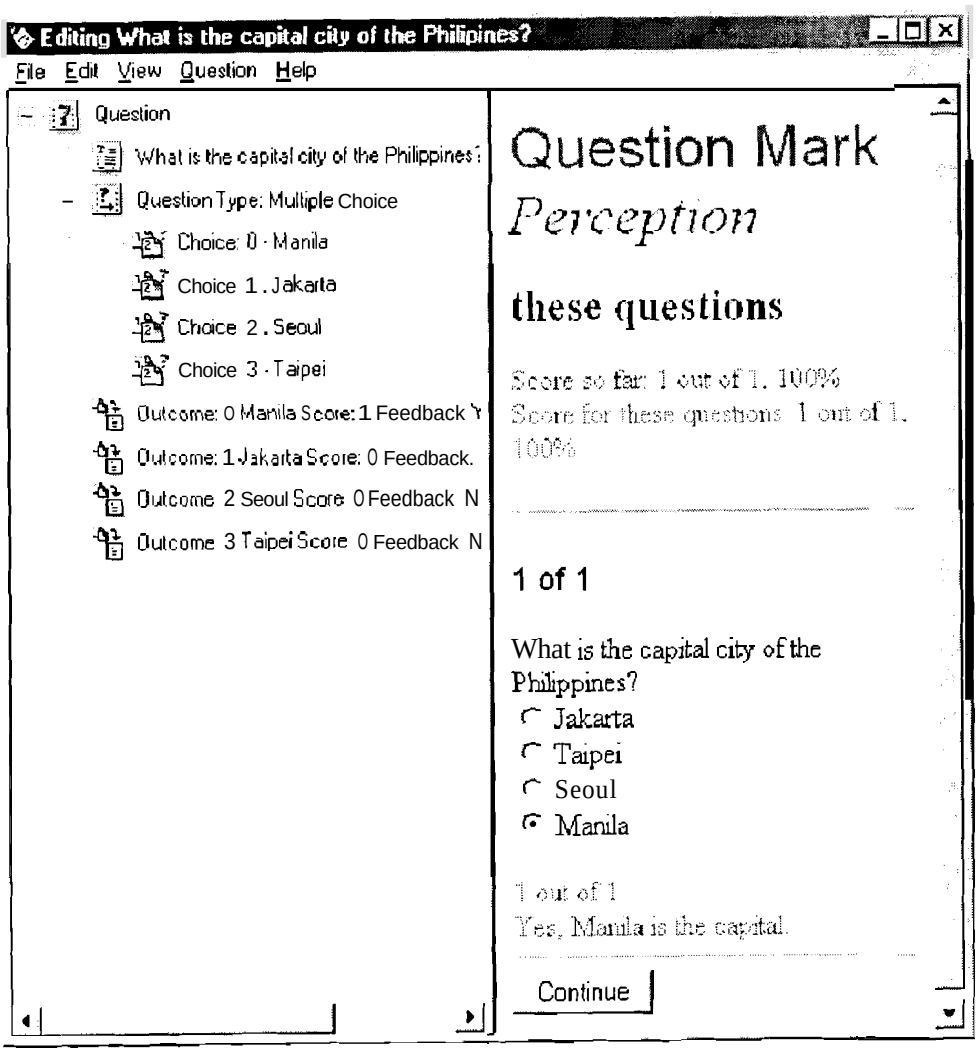
Response Types	Render Types
• XY co-ordinate	• Choice
• String	• Hot-spot
• Number	• Fill-in-blank
• Logical group	• Slider
• Logical identifier	• 'Object'

Detailed descriptions of the outlined specification of the IMS Global Learning Consortiuni can be found at tlie following Internet address: http://www.imsproject.org (10.29.2001). Tlie relationsliip to other standardization efforts is also discussed there.

VI. SYSTEMS

There are a number of companies and institutes which are implementing the IMS specification, or rather, parts of it (see tlie following URLs http://www.imsproject.org/direct/getproducts.cfm (10.29.2001) and also http://www.imsproject.org/direct/getorgs.cfm (10.29.2001)). The range of f'unctions, supported platforms, and price models of systems differ greatly. The palette extends from Windows-based applications for smaller groups to completely web-based environments.

Tlie in- and export of teaching units conforming to the IMS implements for example, Question Mark's Pcrception for Windows and Perception for Web (http://www.questionmark.com (10.29.2001)). The creation of the materials takes place in the very easy-to-use Windows application Perception for Windows. At the same time, the creation of interactive contents is supported by Wizards and a variety of exercise types are offered. A database, included in tlie application, adniinisters the teaching elements and also supports the creation oí'teacliing elements in teams. Tlie authors can test the results of their work in a preview window.



Supplementary to Perception for Windows, the component, Perception for Web, permits tlie contents to be offered in tlie Internet. The elements previously developed under Windows do not need to be worked on any further for that. In addition, courses, course participants and instructors can be set up and nianaged through Perception for Web. Report functionalities allow for tlie assessment of learning progress and test results.

In the realm of Open Source, the Integrated Learning. Information, and Cooperation System (ILIAS) of the University of Cologne (see this address: http://www.ilias.uni-koeln.de/ios/index.html (10.29.2001)) and the Open Knowledge Initiative of the Massachusetts Institute of Technology(http://web.mit.edu/oki/ (10.29.2001)) are backing the specifications of the IMS Global Learning Consortiums. While OKI is still in the planning stages, ILIAS is already available in Vcrsion 2.x. The latter isan efficient, completely web-based client-server-system that offers tools for authors, personalized learning environrnents, adrninistration tools as well as coniniunication and collaboration tools.

VII. CONCLUSIONS

XML-based spcciiications for virtual learning environrnents are in a comparatively early stage of devclopment. As in the case of other standardization efforts, sorne changes and augrnentations are still to be expected. The involvernent on the part of renowned manufacturers and education institutes suggests, however, that great iniportance is given to these types of standardization efforts.

The interchangeability of learning rnaterials and their more efficient production, together with improved accessibility. communicate attractive features of this developrnent. One's own experienccs. which could be gained within the scope of XML-based projects for the creation of language lcarning niatcrials, have been entirely positive. The cost of the developnient oflanguage learning niatcrials was not only reduced by the separation of content and layout, or functionality; tlie project contributors realized that the quality of the rnaterials was also iniproved. Two aspects seem to coniplinient each other in this respect: first, it was possible for the authors to observe the devclopcd XML-contcnts from the learner's perspective at any time and to be able to appropriately assess its appearance. Secondly, tlie XML-DTD, though developed for the learning application but, nevertheless, restrictive, removed the burden from the authors of all the questions concerning tlie layout and other problems whicli usually come up when creating HTML sites. Even tlic prcdcíincd document structure considerably improved the concentration in didactic and content of materials.

'Tlic question rcniains if it would be possible for smaller organizations to come up with cnough financial and pcrsonnel resourccs for tlic operation of such client-server-systems.

Particularly in the university arena, a national approach with a central system management and user support would be conceivable and wise/practical.

LINKS

http://www.imsproject.org
Tlie IMS Global Learning Consortium —provides XML-based specifications tor E-Leariiing systems

http://www.imsproject.org/direct/jetproducts.cmf
Directory of Products and Organizations Supporting IMS Specificatioiis

http://www.imsproject.org/direct/getorgs.cfm
Directory of Products and Organizations Supporting IMS Specifications

http://www.questionmark.com
Questionmark — a company developiiig IMS-coinplieiit products

http://www.ilias.uni-koeln.de/ios/index.html
ILIAS —an opeii source learning management systeiii. which implements features for IMS compatibility

http://web.mit.edu/oki/
Tlie Open Knowledge Initiative (OKI) is defining aii opeii architectural specification to be used for the development of educational related software.

