Computer Aided Learning via the Internet - State of the Art and Future Applications

Michael Gebauer
Regioworld GmbH
Technologiepark 12
33100 Paderborn
Germany
Tel: +49 5251 161940
Fax: +49 5251 1619429
Mail: mgebauer@regioworld.de

Stephan Kassanke
University of Paderborn
Warburger Straße 100
33098 Paderborn
Germany
Fon: +49 5251 60 37 21
Fax: +49 5251 60 35 42
Mail: kass@uni-paderborn.de

Abstract: We live and study in a world filled with information. To prepare citizens for the competition and globalization of tomorrow's world, universities and enterprises are faced with an increasing need for up-to-date information at a reasonable cost. Because of the fast changing requirements of professionals, lifelong learning is required in practically all areas, especially those using information technologies. This article deals with some shortcomings of current Internet standards and proposes a framework for a learning environment based on the extensible markup language (XML).

Introduction

The Internet is still on its way to become a commonly used technology similar to the telephone. Exponential growth rates in almost every country of the industrial world (see figure 1), more than 50% of the population of the United States has access to the Internet, in 1999 more than 10 million people (1998: 6.9 million) aged 14 to 59 using the Internet as an Information and Communication media in Germany [GFK 98], all these facts indicate that this comparatively new technology is on its way to revolutionize our way of living, working and learning. Already today heavy job fluctuation is self-evident for a skilled information elite who possesses a broad qualification profile and can work quite independently of local restrictions via the World Wide Web.

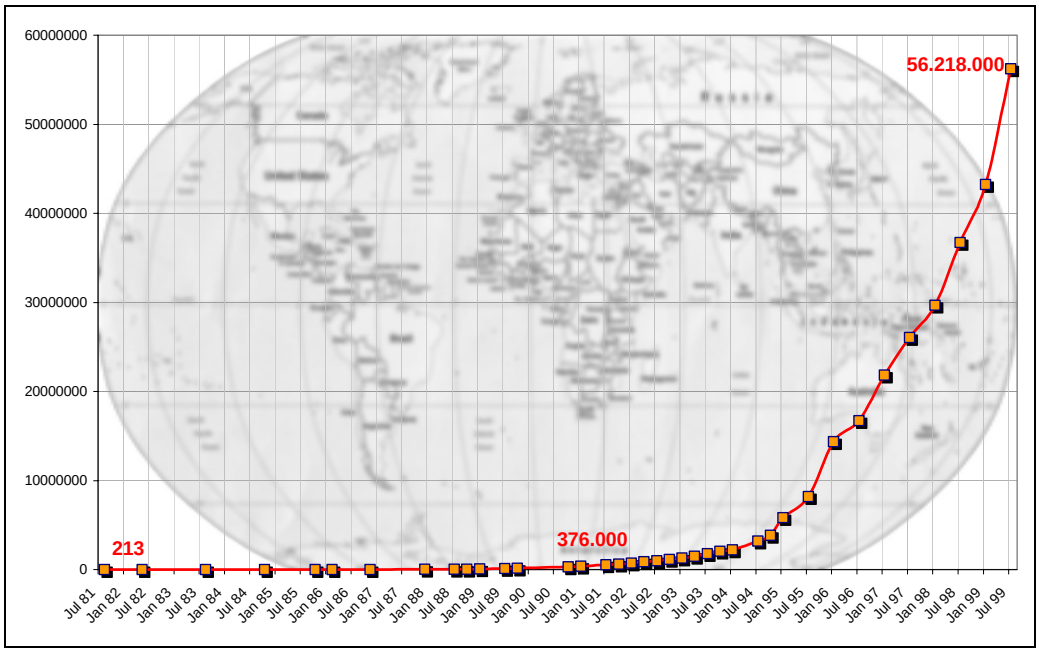

Figure 1: Number of Internet hosts (Source: Internet Software Consortium (http://www.isc.org/)

With this technology evolution in mind we have to think about the Internet as a new way to teach and learn more efficiently. We have to ask for the way of teaching and learning by the Internet, the use and of course the financial impacts of these applications. What is state-of-the-art and how do we develop Internet based education systems to be a real help in the future?

Education and Internet

The use of the Internet as a media to transport information and straighten communication and cooperation in education follows the same rules that every technology implementation goes through. There are four phases according to [MCFAR 73]:

- Initializing
- Infection
- Steering
- Integration

1. Initializing
   First movers (mostly technicians) invent and implement a new technology and are developer and user in one person. The circle of people involved is rather restricted and public interest in the new technology is low. If you take the Internet as an example, in its beginning it was used for communication purposes by a few scientists. Technology was driven by military interests and there was no commercial or educational use of the Internet yet.
2. Infection
   Other people start to recognize the possibilities the new technology offers. Standards begin to emerge and new applications based on the new technology are developed. In our example the Internet technology was enhanced by additional protocols, by the hypertext markup language (HTML) and the creation of the World Wide Web.
3. Steering
   The technology starts to be utilized by a wider spectrum of users. There have to be

people who are responsible for the procurement and the costs of the use as well as there are responsibilities for development and support. Accessing documents on the Internet may be charged by a micro fee.

4. Integration
   The technology is completely integrated in the normal working processes. There are people to be responsible for reengineering and the calculation of running costs and new invests have like every other investment and overhead costs [MCFAR 73]. In our example the Internet is a commonly used tool. The running costs are considered as normal today as the telephone bill.

Current Situation

In our opinion education via the Internet has made the step from the first to the second stage. It is no more the question of “if” but only of “what”, “how” and “what for” [KUB 98]. At this time there are quite a few projects in Germany that cover the educational use of the Internet. One of the most important projects is "Schulen ans Netz" (Schools to the Web) by Deutsche Telekom AG and the German Ministry of Education, Research, Science and Technology. The goal of the project is to give schools, teachers and pupils access to the Internet by the installation of personal computers and conduction in schools. This project can be seen as one of the steps in the phase of Initializing [BMBF 99].

Other projects in the field of professional education are devoted to more self-determined, constructive and communicative learning in open learning structures. Here trainees should be able to work on the basis of their individual skills and interests. They should be facing the possibilities of experimentation, communication and cooperation, for an example see [BAUM 99]. Other projects are the European School Projects [EDU99] and the Open German Schoolnet [ODS99]. All projects focus more on infrastructural problems, not on content and how to work with different content in a more efficient way. An integrated approach for reusing existing material is one of the issues which is not covered by most projects.

Most of the projects mentioned above have not made the step to Integration yet. Especially the field of education can be seen as one of the most important but not open-minded for the use of new technology. Whenever there has been a new technology, especially a new media technique, there was the need to implement and test it for education. So there were projects like School-TV, Video-Production studios or Videotext. They all never made the step from Infection to Steering or even Integration. Even the language laboratories as a new way of learning foreign languages did not go all the way. If we want to bring Education on the Internet to Integration we will not only have to think about technology, but also about transfer and spread, and about continuity and endurance.

This is one of the greatest chances computer aided learning offers. The use of it aids in the improvement of the quality of education and helps by integrating all of the means mentioned above into one platform.

Computer based Learning

Computer based learning itself describes the process of learning based on computer mediated material. The term is used as an acronym to describe various forms of software environments which wrap the learning material. Ideally an underlying didactical model is consequently used, e.g. a hypermedia learning environment motivated by constructivistic principles.

Today learning environments are still mainly delivered on CD-ROM because of technical restrictions the Internet has or bandwidth problems if large multimedia files have to be

transmitted, e.g. videos or similar large files. One example for a CD-ROM based learning environment is “ORWelt”, a learning environment for Operations Research developed at the University of Paderborn [see ORW 99, BKS 99a, BKS 99b, KAS 99].

Commercial authoring environments such as Asymetrix Toolbook or Macromedia Director are available on the market and offer powerful tools to develop proprietary solutions. These tools are extended by Internet facilities for exporting their proprietary format to the Internet. Toolbook for example can export it’s Books to HTML and JAVA, but this possibility is restricted to prefabricated objects, exporting customized code in Toolbook’s programming language OpenScript is not possible.

As we can see the delivery of a learning environment depends on several factors, e.g. the target audience, the equipment being used, even the content (large multimedia files or plain text). Hybrid solutions can also be used to deal with these issues, where video files and large graphics are delivered on a CD-ROM and other material is accessed online. In the simplest case the Internet can be used as a delivery medium such as downloading documents provided by a server. Though the delivery of documents can be improved this way in terms of speed, actuality and accessibility, this does not add a significant value to distributing learning material in traditional forms such as a book. In a next step learning material can be made accessible online through a web browser. This way students can browse the learning material and can view text, graphics and audio material on their screen. Additionally the web offers some inherent communication facilities like email and chat, so students can easily be enabled to communicate among each other.

Drawbacks of Today’s Internet Standards

Today Internet content for education purposes is available but mostly in a static way. The interaction possibilities are restricted compared to the commercial authoring environments mentioned above and maintaining links among documents can be annoying. Coding interactivity in pure JAVA is possible but still too hard for developers of learning modules who are usually not very experienced in programming in JAVA. There are some tools on the market to overcome this restriction, e.g. Macromedia Flash. Using this kind of tools development times for animations can be drastically reduced. The drawback is that users will still need a plugin for their web browser to enable them to take advantage of animation and interaction programmed in Flash. If there is no plugin for the platform you are using you are excluded from viewing the animation or simulation. Therefore the advantage of platform independence is lost in this case.

The worst still is that HTML is not consequently separating content, structure and representation of a document. Furthermore HTML is not extensible by additional tags. If we think of learning objects, other tags than “heading” (<h1>) or “bold” (<b>) for example are desirable. The tagging of learning objects with specialized tags is simply not possible in HTML. Links among documents can only be defined as untyped, unidirectional links.

Due to the lack of support for efficient structuring, retrieval, and linking among very large amounts of documents by standard Web technologies, namely, HTML, JAVA, and Java Script, more general new technologies, such as XML and XSL, are emerging. It seems today that XML will be the successor of the HTML standard.

Now that the Internet use is exponentially growing for about five years, its users are increasingly confronted with problems such as finding particular documents that are located somewhere in the World Wide Web, and maintaining a complex web of shortcuts, links, bookmarks, annotations, access permissions, different file formats, and so on. XML responds

to a strong need to separate content of a document (text, graphics, video etc.) from its logical structure (content table) and representation (formatting on the screen or printer).

XML – the Solution?

SGML (Standard Generalized Markup Language) was defined by ISO 8879. SGML has been the standard, vendor-independent way to maintain repositories of structured documentation for more than a decade, but it is not well suited to serving documents over the Web. XML was defined as an application profile of SGML meaning that any fully conformant SGML system will be able to read XML documents. However, using and understanding XML documents does not require a system that is capable of understanding the full generality of SGML.

In XML you can define an unlimited set of tags. While HTML tags can be used to display a word in bold or italic, XML provides a framework for tagging structured data. An XML element can declare its associated data to be an authors name, a retail price, a sales tax, a book title, or any other desired data element. As XML tags are adopted throughout an organization, and by others across the Internet, there will be a corresponding ability to search for and manipulate data regardless of the applications within which it is found. Once data has been located, it can be delivered over the wire and presented in a browser in any number of ways, or it can be handed off to other applications for further processing and viewing.

The XML Recommendation was published by the World Wide Web Consortium (W3C) in February, 1998. Contrary to HTML, in XML there is neither precisely defined tag semantics nor a given tag set. According to basic rules, the tags can be specified for any application area. Thus, each document in the Web will be tagged with a structure, similar to a catalogue. For example, a learning object might include the tags “keywords”, “author”, “date”, “media elements”, “topic”, “algorithms”, “prerequisite”, “further knowledge” and “content table”. Generally, XML data formats may include far more elements than plain text, such as vector graphics, e-commerce transactions, mathematical equations, server APIs, and so on.

One specific application based on XML is the resource description framework (RDF) which allows one carry a set of meta information along with web documents (see [RDF 99]). RDF introduces a cataloging system, similar to the one used in libraries, for web documents and will improve the speed and efficiency of search engines that are aware of these tags. Today even the best search engines only cover a small subset of the World Wide Web, the structured information retrieval using the RDS meta tags allows for fewer results but more relevant and specific ones. Because RDS is based on XML it can be extended by further tags in the future without affecting existing search engines and other applications operating on the RDS metadata.

Framework “OR-World”

The project OR-World has been proposed in the Fifth Framework Programme of the European Community. It will be lead by the University of Paderborn and different European partners from universities and industries. The goal of the project is to contribute to the development of the European Community by ensuring a more efficient and broader use of its educational system. On top of personalizing the post-secondary education of young learners it will be possible to support lifelong learning of adults within a flexible university. The project supports the four trends as judged by [LNG 96] to be essential in managing the challenges of the 21st century:

1) increased use of educational tools and techniques,

2) greater use of national and international networks,

3) development of co-operative and two-way partnerships, as well as

4) development of learning organisations and individual empowerment.

In the project, we will work on several granularity levels. This means that the general framework will support the following building blocks to be used in constructing flexible, reusable learning environments:

- a *media element*, like text, animation, simulation, video or audio sequence,
- a *learning element* consisting of one or more media elements,
- a *content module* consisting of one or more learning objects, and is understood as a node in the hypermedia network,
- a *thematic metastructure* defining guidelines how to use content modules to build thematic structures relevant for a specific study goal; such a structure can be put together in individual ways, thus adapting to different combinations and profiles.

The term "*learning object*" is generally used to refer to an element at any level of this hierarchy. A given guided network according to the thematic metastructure is also called *learning hyperspace* here.

The IEEE Working Group P1484.12: *Learning Objects Metadata Working Group*, is currently working on standards for describing learning objects. According to the working group, "This standard will specify the syntax and semantics of Learning Object Metadata, defined as the attributes required to fully/adequately describe a Learning Object. Learning Objects are defined here as any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning. Examples of technology supported learning include computer-based training systems, interactive learning environments, intelligent computer-aided instruction systems, distance learning systems, and collaborative learning environments. Examples of Learning Objects include multimedia content, instructional content, learning objectives, instructional software and software tools, and persons, organizations, or events referenced during technology supported learning." We will follow the standardization work and adopt it for digital contents of OR-World as soon as this will be technically possible.

Using the work of W3C as a basis, the OR-World project is related with several current research projects at leading institutes world-wide. For example, the XEROX Palo Alto Research Center is conducting a research project named "Placeless Documents", with focus on how to define the inherent content-aware properties of a document, and separate their description from the secondary properties, like storing format, physical location, size etc. However, the focus of "Placeless Documents" is to manage different technological representations of a certain piece of content; whereas OR-World will focus on hierarchic structuring of contents. Another approach of XEROX, "The Hypertext Concordance" develops methods for automatic, content-driven generation of hyperlinks between documents. The results of this project can, as far as available, be exploited in OR-World to facilitate the generation of the learning hyperspace structure.

The framework will provide a general structured environment to input any (structured or semi-structured) content. A certain level of structuring of the learning material is a prerequisite for applying the framework. The objects at each hierarchy level are tagged with metadata to facilitate their flexible use in different contexts. The framework will be usable in a multilingual environment. It will support networked communication between tutors and learners outside the classroom.

Teachers will be able to use the framework in creating their own specific learning environments where they can combine their own learning objects with those generated by others. Thus, there will be a metastructure above the hyperspace of learning objects allowing different views into a certain subject area.

Conclusion

Computer aided learning is one of the best means to improve the quality of education. Today the technical possibilities allow shifting from CD-ROM based learning units to hybrid solutions or entire web based learning objects. XML is an approach to cope with problems resulting from the unstructeredness of HTML. Today the enormous amount of information available on the web is not accessible because users are drowning in (irrelevant) information. XML structures web documents and makes searching more efficient. Special applications of the XML syntax combined with dedicated tools will allow to define learning objects in a second step. Computer aided learning is still only one component of an efficient educational system and must be supplemented by further support measurements. There is still a long way to go until computer aided learning via the Internet will become the standard way of delivery in the process of life-long learning.

References

[BAUM 99] http://62.104.241.107/, 1/10/99.

[BMBF 99] http://www.san-ev.de/, 1/10/99.

[BKS 99a] Blumstengel A., Kassanke S., Suhl L.: Lernen im Hyperspace - interdisziplinär, interaktiv, intuitiv, integrativ. In: Scheer A.-W., Nüttgens M. (Hrsg.): Electronic Business Engineering. 4. Internationale Tagung Wirtschaftsinformatik 1999. Physica-Verlag, Heidelberg, 1999.

[BKS 99b] Blumstengel A., Kassanke S., Suhl L.: Learning management science in hyperspace. In: Gries T., Suhl L. (Ed.): Economic Aspects of Digital Information Technologies. Gabler Edition Wissenschaft, Wiesbaden 1999.

[EDU 99] http://www.educ.uva.nl/ESP

[FER 99] http://www.fernuni-hagen.de/ESGW/ERZBIL/TDS/lehrgebiet/ag3.htm, 1/10/99.

[GFK 98] http://www.medien.de/gfk/monitor/ppt/sld001.htm, 1/10/99.

[KAS 99] Kassanke, S.: "ORWelt - a Hypermedia Learning Environment for University Lectures in Operations Research", Proceedings of BOBCATSSS Symposium 99, Bratislava, 1999.

[KUB 98] Kubicek, H. / Breiter, A.: Informationstechnik-Management als kritischer Erfolgsfaktor für den Multimediaeinsatz in Schulen[1]. In: Kubicek, H. et al. (Hrsg.): Jahrbuch für Telekommunikation und Gesellschaft, 1998. Heidelberg, S. 120-129.

[LNG 96] Norman Longworth, W. Keith Davies: Lifelong learning – New vision, new implications, new roles for people, organizations, nations and communities in the 21st century. Kogan Page, 1996

[MCFAR 73] F. W. McFarlan, R. L. Nolan and D. P. Norton: Information Systems Administration. New York et al: Holt, Rinehart and Winston 1973.

[ODS 99] http://www.be.schule.de, 1/10/99.

[ORW 99] http://dsor.uni-paderborn.de/en/orwelt.html, 1/10/99.

[RDF 99] http://www.w3.org/TR/PR-rdf-syntax/, 1/10/99.