A Framework for Authoring Mobile Learning Content (Mobile Microlearning)

Elisabeth Gugerbauer
Johannes Kepler University of Linz (Austria)
Department of Telecooperation

Abstract: In order to facilitate simpler ways for (m-/e-) learning content there is a need for special tools supporting the authoring process and considering both, the technical challenges of content creation (e.g. adaptation of content to various types of mobile devices) as well as pedagogic and didactic issues in content creation (e.g. what is the appropriate granularity of a unit in mobile learning). This paper clarifies these needs and presents an authoring framework which provides both types of support.

1. Motivation

With the advances in communication infrastructures and the widespread availability and usage of mobile devices, a trend in the eLearning community is observed integrating those mobile technologies also into learning environments. However, mobile learning is more than just providing access to learning content via mobile devices. New ways of learning, such as situated learning, ad hoc provisioning of learning content, spontaneous interaction in learning groups, and personalization can and should be considered. While most research in mobile learning has focused so far on providing learning environments supporting the management of and the interaction with learning content, less work has been done on providing support for authoring content suitable for mobile learning. For this reason solutions are looked for which combines the specialized knowledge of authors with authoring tools.

2. Issues in Content Creation

2.1 Technical Content Preparation

Content preparation requires both, highly developed technical standards for content

presentation and delivery presentation and substantial knowledge in the content domain itself. Frequently a trade off between technical possibilities and content conversion has to be found in order to achieve the best result. Unfortunately automated support in content authoring cannot be fulfilled. Help based on content is up to now not realizable. No general concept can be defined restricting the structure and the content. Maximum ratings about the length of a document, the relative multimedia support of content units (amount of multimedia elements within a document) and other similar global parameters can be defined; however don't conform to any content. Because of the complexity of language and semantic ambiguity, semantic guidelines focusing the content are not realizable as well. Simple programs comprising as well defined technical help assistance may support not so highly technical educated authors; however these programs are not able to exploit the whole technical equipment.

2.2 Gap of Technical and Knowledge-Based Content

Except for technical reports comprising content and technical knowledge, a huge gap between knowledge-based content and technical experiences with content perception appears. For this reason compromises are looked for, bridging the gap between technical content and knowledge-based content preparation. Frequently (online) content preparation and knowledge-based content research are separated. Knowledge is provided by content-experts and prepared by technical experts. Unfortunately the content suffers due to the separation of knowledge and technical preparation. Knowledge may be ambiguous, misunderstood or simply wrong structured. The lack of mutual understanding enlarges the gap between technical and knowledge-based content and the compromises concerning the final content product are frequently not sufficient. The primary goal for publishing content suitable for mobile learning is identified in eliminating this gap between the technical and the knowledge-based part of content preparation.

2.3 Support for Content Creation

Support for content creation can be offered in various ways. As already mentioned before parameters like the length of a document, the amount of multimedia objects (images, animations, applets), the structure of the content (with XML support), and up to a certain level the meaning of the content (by semantic node names) may be documented assuming that the topic of the content is predefined. Impact on the content may be assured by content classification and predefining possible structures and templates (q.v. chapter 3.3 Content-Based Help). In order to provide adequate help for

authors, a combination of various support strategies is necessary, otherwise the interpretation and preparation of content will depend on technical content structures or will provide a lack of knowledge again.

2.4 Advantages of Content Supported Learning Units

Having impact on the content itself, reduces the gap between technical and knowledge-based content and supports authors in publishing content. Additionally the possibility to publish content modules, comprising several units containing similar structures (even published by different authors) is offered. Authors get the facility to evaluate content by themselves. (Online) Content preparation will become simpler; less time-consuming, detached from up to now necessary document format rules and independent of the authors' technical experience.

3. (Didactic) Help on Content Establishment

3.1 Base (MobiLearn)

In the MobiLearn[1] project, a structured approach for annotating learning content has been developed extending and detailing existing eLearning standards. A document type definition (DTD[2]) has been established which defines structures for online content stored as XML documents to be delivered to different types of end devices (PC, PDA, phone) and to be viewed at different levels of detail (so-called LODs[3])[4].

Although the DTD defines the available types of learning objects, this is not sufficient to ensure and support their usage in a standardized way. In fact, analysis of the learning modules developed in the MobiLearn project revealed significant differences in structure, such as semantic ambiguity or even misuse of content elements. The lack of specific content authoring software caused a depreciation of the final content and raised questions for improvements. Further details about the MobiLearn project analysis are published within the thesis.

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1 MobiLearn Website: http://www.mobilearn.at
2 DTD: http://www.w3.org/TR/html4/sgml/dtd.html (accessed Oct, 2006)
3 LOD = Level of Detail (slides, script, further information)
4 Johannes Kepler University of Linz, Technical University of Vienna, J. (2002), "Description of the MobiLearn DTD"

Based on the MobiLearn project, the objective of this work was thus to design and implement a framework for authoring mobile content which should demonstrate different ways of (didactic) authoring support. The "Didactic MobiLearn Editor" has been established (q.v. chapter 5 MobiLearn-Editor).

3.2 Requisites

Necessary for content-based help are a predefined content-structure (e.g. DTD, XSD[5]), a restricted topic and a straight conceivability about the target-group. The MobiLearn project complies all these requisites (structure: *MobiLearn DTD*, topic: *media computing,* target group: *students*). Relying on the MobiLearn project, the "Didactic MobiLearn Editor" has been implemented, which is based on these requisites and demonstrates a proper way for authoring-support.

3.3 Content-Based Help

Content-based help comprises the overall workflow of content-authoring, starting at the choice of the proper authoring tool and ending at proof readings and analysis of the finished content. The impact on the content itself is restricted because of semantic ambiguity and individual authors. Nevertheless authors may be supported by producing content. Simple frameworks, only offering the necessary content-producing features facilitates the production of learning-units as well as a strict separation of file-format and content-structure. Authors must not be confused by difficult instructions, which are necessary to exploit the offered features of content-establishing tools.

Sometimes simplicity optimizes the results. Predefined structures and templates support especially new authors who have to get used to the construction of learning-units and its' application. Learning-units which are connected to a predefined structure (DTD/XSD) must be well prepared to the author (e.g. presentation of proper child-nodes). Otherwise the complexity offered by predefined structures can never be used. Content marks for highlighting and online proof-reading possibilities enrich the establishment of learning-units additionally. Structure-comparisons and -analysis with other learning-unit-modules provide a better general view and give authors the possibility to check finished learning-units with former, already published and used ones.

5 XSD: http://www.w3.org/XML/Schema#dev

4. Related Work

A couple of m- and eLearning projects have already dealt with content-authoring tools. Some of them are focused on the integration of multimedia, interactive objects and take less attention to the usability. Others try to simplify the programs in order to enable learning-content-publishing easily. Unfortunately the functionality of the authoring-system suffers from the emphasis of convenience.
The EF-Editor and the eXe-Editor are two examples of current content-authoring-tools.

4.1 EF-Editor

The Technical University of Dresden[6] and the Department for Pedagogical Psychology and Deployment-Psychology[7] published the EF-Editor. The EF-Editor (Exercise-Format-Editor) is a subproject of the "Studierplatz 2000" project. The aim of this project has been to establish knowledge actively and by communication. New learning and teaching strategies are supported by new media.
The EF-Editor enables the development of interactive objects. Unfortunately format and content are not separated, thus authors have to develop difficult structures (script-tags, media-tables,…) and have to combine Microsoft Word documents with the established components of the EF-Editor. Numerous templates (MS Word templates, EF-Editor content restrictions) have to be obeyed in order to publish learning content.
The EF-Editor is a very powerful tool, offering numerous features for content-creation. However, the handling of the EF-Editor is very difficult and only a few authors are able to exploit its offerings.

4.2 eXe

The eXe-Editor (eLearning XHTML editor) is an open source project of the University of Auckland[8] (New Zealand). eXe enables the publishing of eLearning-based learning units. The aim of this project has been to develop an intuitively, flexible und easy-updateable learning-content editor.
The whole editor is based on an interactive website. eXe may be controlled by a spe-

6 TU Dresden: http://tu-dresden.de/
7 Department of Pedagogical Psychology and Deployment-Psychology: http://psylux.psych.tu-dresden.de/i4/index.html (accessed Oct, 2006)
8 University of Auckland. http://www.auckland.ac.nz

cial version of Mozilla Firefox[9], provided by the eXe project. The navigation within the editor is quite simple. Different objects (e.g. Activity, Case study,…) may be added to the learning-content and build-up the final structure. Out of the combination of these objects the learning-content is established.
The functionality of the eXe-Editor is – compared to the numerous possibilities of the EF-Editor – restricted. Although the authors may structure the learning-content by the different elements, interactive objects are hardly supported. For additional need the integrated "iDevice-Editor" offers the possibility to create individual objects.[10]
All in all the eXe-Editor is a highly user-friendly, simple to use program, offering the opportunity to create simple HTML- and SCORM-learning units.

4.3 Implication

Both, the EF-Editor and the eXe-Editor are very mature systems. The EF-Editor especially supports the interactivity and activity of learning-units. The eXe-Editor has a much simpler interface and an easy-handling content-establishing tool.
However, both systems don't have impact on the learning-content. Authors have the duty to define the learning-target-group, the learning-habits of the learner and also have to look for a proper learning-content-structure for the learning-unit by themselves. Content-establishing-help hasn't been integrated yet, although numerous authors are overextended by the content-publishing.
Current authoring-systems concentrate mainly on either the interactivity of content (especially within mobile learning environments) or usability. The impact on the learning-content is up to now not integrated because of semantic lacks and ambiguity.
Authoring systems have to be developed which support both: technical facilities and content-support.

5. MobiLearn-Editor

5.1 Implementation

The "Didactic MobiLearn Editor" has been developed using the Microsoft Visual C# .Net framework[11] because of its' good support for graphical user interfaces (GUI). The

9 Mozilla Firefox: http://www.mozilla.com/firefox/
10 University of Auckland (New Zealand) (2005), "eXe – The eLearning XML Editor"
11 C# – Microsoft Website: http://msdn.microsoft.com/vcsharp

established learning-units are based on XML files connected to an XSD. The editor enables all for the publishing of MobiLearn-content necessary steps. Figure 1 shows the final learning-content editor.
It comprises three main parts: the main-window, the content-window, and several functional-windows.

- Main-window
  The main-window controls the program. Available learning units are opened, new learning units are created, selected learning units are saved, and various previews can be generated.
- Content-window
  Within the content-window learning-units are presented and can be edited in the window directly. All changes are directly adapted to the XML-file. Using hidden IDs the content-window is straightly connected to the functional-windows which have an enormous impact on the content of the learning-unit.
- Functional-windows
  The functional-windows represent the (didactic) features of the editor. The features comprise the selection of proper child nodes as well as a learning-theory analysis and other features described later in this paper. Additionally the functional-windows present the library of the learning-unit (available media-objects which may be added to the content) and allow authors to change the attributes of the structural-nodes.

5.2 Features

5.2.1 Simple Framework

Frequently software vaunts because of numerous features and opportunities, however, in some cases clear simple structures and navigations justified on the user's needs are much more efficient. For this reason a simple navigation, logical steps and no superfluous features are added to the "Didactic MobiLearn Editor". The editor's features are concentrated on the author and on the learning-units.

5.2.2 Separation of File Format/Content Structure

File format and content structure must be separated in order to guarantee content which is completely independent of the authors' technical knowledge. Learning environments – requiring specific code lines within the actual content – restrict the authors'

creativity and inspiration. Therefore a straight interface becomes obligate.
With the help of the "Didactic MobiLearn Editor", authors edit and produce content directly in an editable and embedded Internet-Explorer-component, rendering the learning-unit in XML style. Content-configurations (q.v. chapter 5.2.5 Content Marks) are supported by visual aids and are completely separated from the final XML-output.

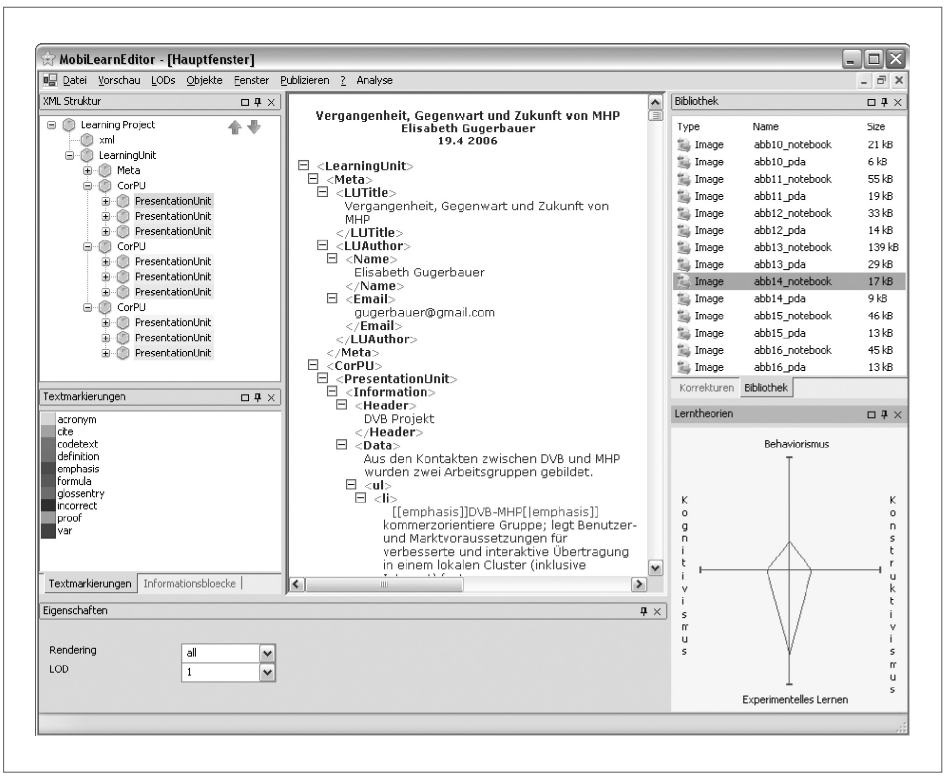

Figure 1: Didactic MobiLearn Editor

5.2.3 Predefined Structures and Templates

In order to simplify and optimize content authoring structures may be defined and offered to the authors. These structures mainly cover general information (e.g. references) and can be integrated within content easily. Templates have more impact on the content itself, aimed either on content issues or on target groups (e.g. by the use of learning theories). Such templates support authors creating content for the first time or

may be established/adapted by experienced authors, wanting similar content structures for learning unit series.
During the development of the "Didactic MobiLearn Editor" and the analysis of m-/eLearning environments and learning theories, templates have been established which concentrate on the one hand on learning theories (behaviorism, constructivism, cognitivism and experimental learning) and on the other hand on target-groups (elementary school, lower grad, upper grade, scholastics, and adult education). These templates may be used for the establishment of learning-units, supporting new authors or providing similar structures of learning-units-modules. Changes, extensions and adaptations on the content and on target groups are facultative.

5.2.4 Child-Node Presentation

Depending on the rules of a DTD/XSD, content-nodes and content-child-nodes have a strict sequence. In order to obey these rules the capacities of the whole structure is frequently not used. Elements are unacquainted, structures are not well enough defined. By presenting all node possibilities (e.g. by selecting a node all proper child-nodes are presented), the whole complexity may be exploited easily.
The "Didactic MobiLearn Editor" presents proper child-nodes by a functional-window. If an author selects an XML-node of the learning-unit structure, all possible child-nodes are presented. Nodes which have to be included are highlighted. Because of this structure only nodes can be added to the learning-unit which obey the predefined DTD/XSD structure. The DTD/XSD restrictions are directly selected by the DTD/XSD-file and are for this reason exchangeable.

5.2.5 Content Marks

Content highlighting and adding specific marks avoid content ambiguity and provide the possibility to give hints to the most important parts of the content. A well defined list of unique marks (e.g. emphasis, cite, proof) enriches content enormously.
Within the "Didactic MobiLearn Editor" authors voluntarily mark parts of the learning-units. The marks are all highlighted by different colors in order to intensify the marks. Marks are again, directly added within the text-paragraphs. Additional comments or special text-mark-tags need not be added manually.

5.2.6 Learning-Unit Slider

Voluntarily authors derive learning units by predefined content structures or even tem-

plates (depending on learning theories or target groups). By providing authors a kind of visual monitoring (e.g. sliders showing template approximation by values between 0 and 100 or visual guides demonstrating correspondence by distance), content can automatically be compared with template necessary structure guides.
The "Didactic MobiLearn Editor" concentrates on the learning theories behaviorism, constructivism, cognitivism and experimental learning. For this reason a graph has been implemented which visualizes the tendency of the current learning-unit, by a dynamic four-sided figure (see figure 1, bottom right).

5.2.7 Proof Reading Features and Requirements

Testing finished content may either be done by proof readers, checking the content on spelling errors, ambiguity and even knowledge mistakes or by potential target group members, checking the understanding and learning results. In order to use these remarks globally, the possibility for proof reading marks - similar to content marks - should be guaranteed. These marks need not have emphasis on the final content, however, must be clearly demonstrated to the author in order to reengineer content passages.
In order to facilitate online corrections by various authors, the "Didactic MobiLearn Editor" offers the possibility to add marks to the learning-unit which haven't any impact on the final published learning-unit. Marks like *"Check the content again."*, *"Add additional media objects."*, *"Proof spelling."* or *"Illustrative material missing."* may be added to the learning-unit and reengineered by the author.

5.2.8 Content Comparison and Analysis

Especially at the beginning of content authoring uncertainness about the final content, context and structures occurs. Learning units are hardly ever compared with other content and therefore authors have to either trust their own experience or have to look for content comparison by themselves. If content is well enough structured (e.g. XML structure), content comparison and analysis become possible. Authors may check the established content automatically with other similar structured learning units (Statistics about similar learning units are necessary).
During the MobiLearn project 12 learning-modules, comprising several learning-units about the topic "media informatics" have been published. These learning-units have been analyzed and are used for content comparison and analysis (length of a learning unit, amount of media data, amount of elements, amount of different elements, amount of rendering attributes, amount of LOD attributes,…). The "Didactic MobiLearn

Editor" checks the current learning-unit and compares the values with the MobiLearn project statistics. The results are published within the editor. If authors generate a learning-unit-module, they can additionally compare the whole module with the MobiLearn project statistic. These generated statistics may also be used for content-reengineering. Published learning-units become more homogeneous and students need not habitude on different learning-unit-styles.

6. Conclusion and Future Work

Depending on the level of information about the content itself (e.g. like within the MobiLearn project by managing content by different information-unit-blocks), automated content support becomes possible. Even if restrictions by semantic lacks remain, opportunities will occur simplifying content authoring. Additional features like defining content structures by simple restrictions (target group, topic, extent, possible learning theory, and others), content derivation from existing learning units, content combinations, content linking and many others will arise.
The proposed authoring framework should demonstrate that the possibility for supporting authors in publishing learning-units may be guaranteed. In order to establish m- and eLearning content for learning-environments, simple, user-friendly, and author-supporting authoring frameworks must be established simplifying the production of learning-units. Content establishment has to become much more intuitive, self-explanatory and independent of underlying formats. Achieving this goal gaps between technical expertise and content domain expertise will be eliminated and content creation will depend solely on its topic.

7. Acknowledgement

I would like to thank Univ.Prof. Dr. Gabriele Kotsis for supervising my PhD, for her comments and critics, for her advices, for her help during the implementation of the content authoring framework and for the conception and authoring of my thesis.

8. References

Schulmeister R. (2004), "Didaktisches Design aus hochschuldidaktischer Sicht"
Kraußе R./Zschenderlein U. (2004), "Das Exercise Format (EF) Version 0.94"