[MZRSt07] *Marek Meyer, Birgit Zimmermann, Christoph Rensing, Ralf Steinmetz;* **An Interactive Tool for Supporting Modularization of SCORM-Based Learning Resources;** World Conference on Educational Multimedia, Hypermedia and Telecommunications (EDMEDIA 2007), Vancouver, Juni 2007, Proceedings on CD.

An Interactive Tool for Supporting Modularization of SCORM-Based Learning Resources

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Abstract: Reusability of Learning Resources has been a research issue for many years. There are several theoretical solutions for enabling efficient reuse of Learning Resources. In practice though, reuse is still far behind its potential. One key requirement for reusability is to have small, modularized Learning Resources available. These small Learning Resources can then be aggregated to new Learning Resources. But repositories contain mainly whole courses, which are unlikely to be reused as such. Learning Object Repositories could be much more successful, if they contained more fine-grained Learning Resources which are better suited for reuse.
As an intermediate solution, we propose the use of a modularization tool for decomposition of existing monolithic learning resources. This paper presents a concept for an interactive modularization tool for SCORM-based Learning Resources and an actual implementation of that concept.

Introduction

Over the last years, reuse of Learning Resources has been an important topic in E-Learning research. However, most research is focused on academic environments and heterogeneous systems. For small and medium sized enterprises, the existing reusability approaches are often not applicable. For these enterprises, the costs of content production and missing didactical and expert knowledge for particular topics are challenging obstacles. An approach to

overcome these challenges is to trade existing contents among those companies at affordable prices. The Content Sharing project is a public funded project in Germany aimed at fostering the exchange and reuse of E-Learning contents. The core of the Content Sharing project is an online marketplace for Learning Resources. But being able to trade Learning Resources does not yet mean that reuse of these contents is feasible. As the learning and teaching context differs between different companies and users, the contents often have to be adapted to the new context to achieve an optimal learning experience (Zimmermann 2006). Instead of reusing whole courses as one piece, the customer wants to build a new course out of materials from different sources. A prerequisite for this kind of reuse is the availability of fine-grained contents. Either the contents are traded already as small, modular Learning Resources, or the available Learning Resources have to be modularized before reuse.

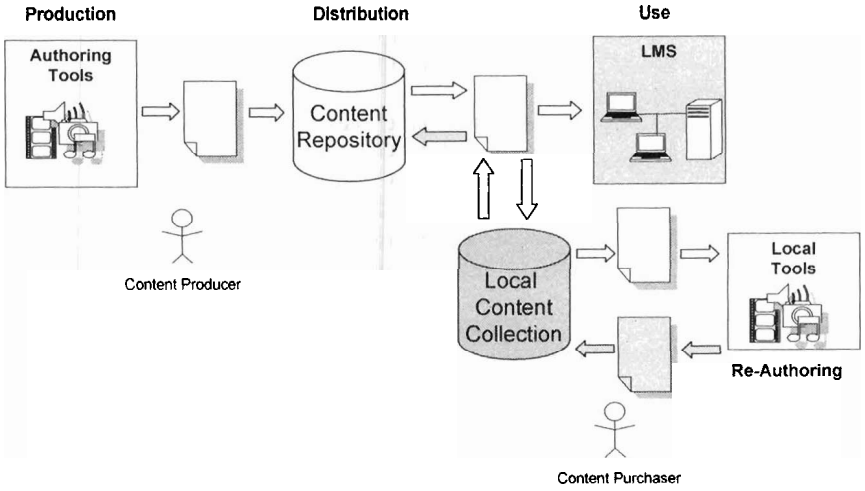

Figure 1: Content Sharing scenario - actors, repositories and tools.

The Content Sharing system serves as a scenario for this paper. It is assumed that a Learning Object Repository exists, which is used by two types of actors: content provider (or producer) and content purchaser. The scenario is illustrated in (Fig. 1). If the content purchaser uses the obtained Learning Resources as input for creating or deriving new Learning Resources, he may also be called a reusing author. The most common Learning Resource format in this scenario is SCORM 1.2 (Advanced Distributed Learning Initiative 2001). The newest SCORM version 2004 is not yet used by most content producers of the target group.

This paper will discuss the different ways to achieve reuse of fine-grained contents, present a concept for an interactive modularization tool and an implementation of that concept for SCORM Learning Resources. The paper is structured as follows. The second section discusses related work on reusability, aggregation and modularization of Learning Resources. Section three introduces a concept for modularization of Learning Resources. The implementation of that concept is presented in section four. Results of a usability test are discussed in section five. And finally, the sixth section draws conclusions of the work and gives an outlook for future work.

Reuse of Learning Objects

Reuse of Learning Resources is considered to be a key factor for efficiency in E-Learning. Only if contents are reused several times, the high costs of content production pay off and allow a wide use of E-Learning technologies. Many definitions have been formulated for Reusable Learning Objects, which should facilitate the reuse of existing contents (Polsani 2003). Authoring by aggregation is an authoring paradigm for creating new Learning Resources by selecting and aggregating existing Learning Resources (Duval & Hodgins 2003, Hörmann 2005). In practice, however, reuse of existing Learning Resources is still very difficult. Especially, if an author wants to reuse existing Learning Resources to integrate them into a new Learning Resource, some obstacles have still to be faced.

The common exchange format for Learning Resources is the Sharable Content Object Reference Model (SCORM). SCORM allows defining several sharable content objects (SCOs), which also could be reused independently. However, it is inconvenient for a user to decompose a large SCORM course into several individual SCOs. Available SCORM tools, such as the Reload Editor, support only the export of one section at one time. Furthermore, many courses which comply to the SCORM standard at first glance, actually contain only one SCO which encapsulates the whole course contents. This type of courses will be referred to as Single-SCO course in this paper.

The ALOCoM system decomposes documents, such as slide presentations into smaller fragments, converts them into an intermediate format and stores them separately in a repository. ALOCoM enables aggregation of these fragments and transformation into target formats (Verbert et al. 2006).

A Concept for Learning Resource Modularization

In our scenario, authors want to reuse existing contents, especially parts of existing SCORM packages, for creating new Learning Resources. There are basically three modularization modes which differ in when, how and by whom Learning Resources are modularized. The three modes are listed in (
Table 1). The table gives for each modularization mode the dissemination phase in which the modularization takes place, the actor who performs the modularization and the possible degree of interactivity. The three modes are modularization by producer, modularization by repository and modularization by recipient, as depicted in (Fig. 2). The term *module* is used in this paper as a short form for modular Learning Resource.

Modularization Mode	**Dissemination Phase**	**Actor**	**Interactivity Mode**
Modularization by Producer	Before upload to repository	Content Producer	Interactive
Modularization by Repository	At repository, after upload	System (Repository)	Automatic
Modularization by Recipient	After delivery	Reusing Author	Interactive

Table 1: Modularization Modes.

Modularization by Producer. In the first case, the content producer modularizes the contents he has produced to allow recipients to reuse particular parts of his contents individually. The producer retains control about which parts may be separately used and which not. This mode, though, does not regard the reusing author's needs; the recipient has no influence on granularity and number of target modules.

Modularization by Repository. If modularization takes place after a content producer has submitted a Learning Resource to the repository, the mode is called modularization by repository. The system is the actor and decides on what and how to modularize. Human users cannot influence the process, neither producers nor recipients. On the other hand, the achieved automation is the most time efficient modularization method for the involved human actors. In addition, a standardized procedure may improve the overall quality and availability of modularized Learning Resources.

Modularization by Recipient. The third modus operandi is to let the reusing author to modularize a Learning Resource according to his actual requirements. This approach enables the content recipient to extract and reuse exactly the contents he needs. However, this mode is more time-consuming for the recipient than to simply download already modularized Learning Resources. Drawbacks of this approach are increased download sizes and that it is more difficult to find Learning Resources, which contain the desired contents.

In summary, all three modes make sense in certain scenarios. There is not one superior mode, but all modes have advantages and disadvantages for the involved human actors. The choice of a modularization mode depends on the particular interests of content producers and potential recipients and their influence on the decision.

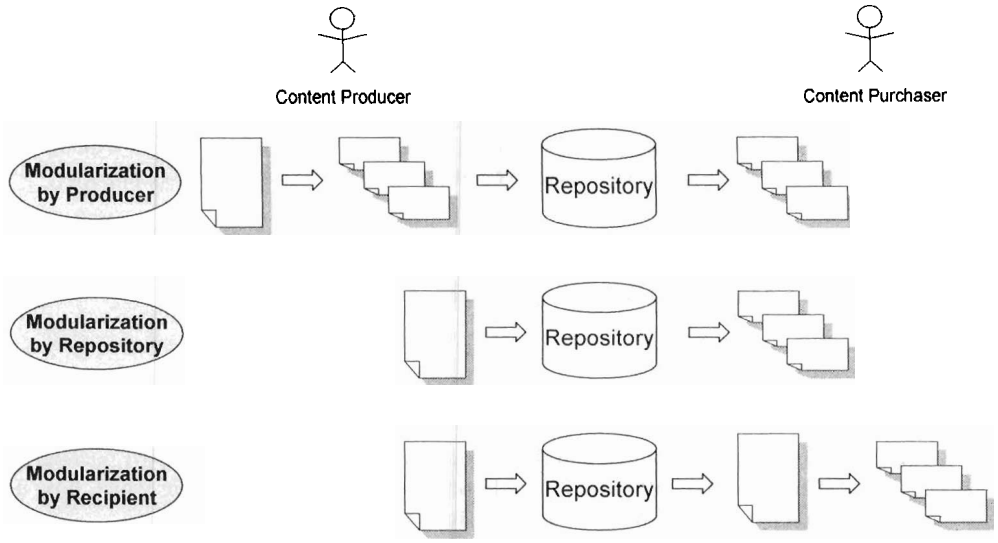

Figure 2: Modularization modes.

For the initially described scenario, an interactive modularization approach has been chosen. The goal is to support both, content producers and reusing authors, by an interactive modularization tool. Content producers may either modularize a Learning Resource before dissemination, or distribute it as a monolithic Learning Resource. Reusing authors may obtain either already modularized Learning Resources or modularize them just-in-time for their reuse purpose. Reuse and modularization might be restricted by content producers by terms of a license; however, legal issues are out of scope of this paper. More details on this topic can be found in (Hansen & Selmeczi 2006).

The modularization tool concept presented here has been created and revised based on several interviews with both, content producers and content users from the Content Sharing project. A modularization tool for this target group should be able to deal with SCORM packages, as this is the most common format for web-based Learning Resources. Users also want to get as much support as possible from a tool; ideally, the tool should propose reasonable module boundaries. On the other hand, they want to be able to freely adjust module boundaries. It is a challenge to find a balance between freedom of choice and simplification. And finally, users from the target group have asked for support in metadata generation and handling. An often mentioned demand is to have the tool propose as much metadata as possible. This also matches with the observation made by Hörmann (2005).

According to the user's requests, the tool should support the user by suggesting module boundaries but allow him to alter the suggestion if needed. This shall be achieved by generation of an outline of the course structure. The outline begins with the structure of the SCORM manifest but should reach deeper into SCOs if they consist of several pages. The outline is presented to the user as a tree. Target modules are visually represented to allow the user to easily overview and understand what will be the result of the modularization. Proposals for reasonable module boundaries are provided by the modularization tool, but can afterwards be modified by the user. Additional support should be provided to the user by giving him more information on the contents of individual structural elements by performing a content analysis.

When the user is satisfied with the determined module boundaries, the modularization tool should automatically decompose the Learning Resource according to the chosen boundaries. The modularization process results in an aggregate of separate modular Learning Resources. The tool concept also includes the usage of metadata strategies. A metadata strategy is a replaceable method which generates a new metadata record out of a given set of input factors. The input factors in this case are the metadata record of the original Learning Resource, the contents of the new Learning Resource and context information, such information about the user, the system and the modularization process, which has been performed. An interactive metadata strategy could also use a user dialog for obtaining additional information from the user or to verify metadata proposals.

An Interactive Modularization Tool

Based on the concept of section three, a modularization tool has been implemented. The tool has been embedded into the Module Editor of the Content Sharing project. As a platform for the application Java and the Eclipse Rich Client Platform (RCP) have been chosen. The basis system of the Module Editor provides handling and editing of SCORM packages. The features of the basis system comprise version management, a plug-in mechanism for integrating different repurposing tools and lifecycle information tracking. A repurposing framework serves as an infrastructure for facilitating the development of repurposing applications (Meyer et al. 2006b). Repurposing tools can access an abstract format-independent representation of a Learning Resource. Changes of the contents and structure are specified as modification commands, which can be performed tailored to different document formats (Meyer et al. 2007). Content analysis methods may also be plugged into the framework for annotating the contents with additional semantic information (Bergsträßer et al. 2006).

The modularization tool uses SCORM 1.2 as base format, because it is currently still the most used SCORM version. In order to support modularization of Learning Resources and a subsequent aggregation by reference, the SCORM format has been extended (Meyer et al. 2006a). This extension has been designed to retain SCORM compliance; each individual or aggregated Learning Resource, which has been processed with the tool, is usable in common SCORM environments such as Learning Management Systems. (Fig. 3) illustrates a view of hierarchically aggregated modules.

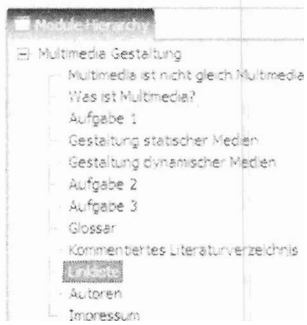

Figure 3: Module hierarchy.

Modularization of Learning Resources can be embodied as a linear process of consecutive process steps (Meyer et al. 2006c). Therefore, the modularization tool has been designed as a wizard, which leads the user through a sequence of process steps. According to the process model, the four steps *preprocessing, content analysis, boundary determination* and *technical decomposition* have been implemented as wizard pages (Fig. 4). *Post-processing* has been implemented non-interactively in the form of a metadata strategy.

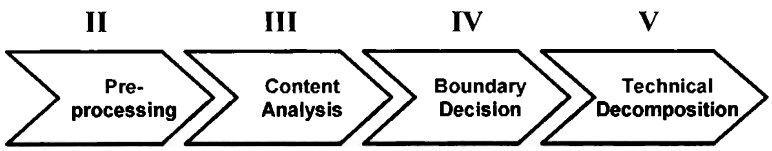

Figure 4: Modularization process.

Preprocessing is the first explicit phase of the implemented modularization process. Preprocess means to transform the Learning Resource into a form which is better suited for modularization. In the present implementation, the assignment of files to SCORM resources is completed. Motivation for this step is that the SCORM specification is too lax concerning the resource definition. The usage of *file* elements is optional, which leads to SCORM packages

in which no explicit connections between files and resources or items are available. Decomposition becomes more difficult for these SCORM packages, because the decomposition method has to guess which file belongs to which SCO or asset. To relieve the actual decomposition method from those concerns, file assignments are determined and made explicit in an early stage.

In a second process step a content analysis takes place. Goal of the content analysis is to provide the user with more information about the contents of structural elements, such as SCOs and assets. Again, implicit information is made explicit for simplification. The implemented content analysis method determines if a structural element could be an introduction, definition or example. If one of these types occurs, the type is written as annotation to the content representation. The information is used later for presentation to the user.

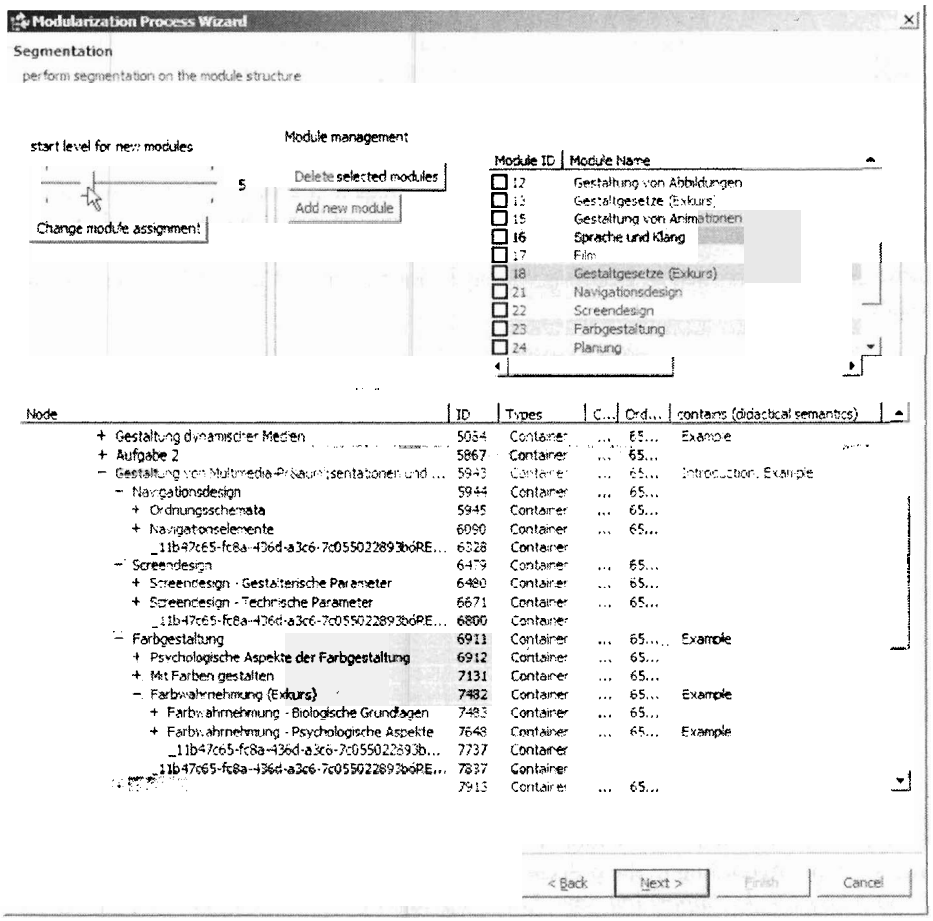

Figure 5: Boundary determination view.

The third step of the wizard is considered the main screen of the modularization process. The user is presented an abstract outline of the Learning Resource. Module boundaries are determined in this view. The Learning Resource outline contains the semantic annotations that have been generated in the previous step. (Fig. 5) shows the boundary determination page. There is a slider for the user to control the granularity of boundary proposals. The user may select the structural depth at which new modules are proposed. Each target module is assigned a unique color to help the user to distinguish the modules. When the user moves the slider, new module boundaries are proposed. He may afterwards add or delete target modules and reassign individual structural elements to different target modules. The title of the first structural element in a target module – if such a title exists -- is proposed as title for the module; this rule of thumb has proved in practice to satisfy the users. All in all, the implemented boundary determination view provides a mix of user guidance and freedom of choice. The user is not restricted in his choice of module boundaries, but may also benefit from the interactive support for ease of use.

After the user has confirmed the chosen module boundaries, the physical decomposition takes place. As all dependencies between structural elements and files are already known from the preprocessing phase, the structural elements are moved to newly created target modules. If a file is required by more than one structural element, it is copied instead of moved. The decomposition is solved as a modification command as described in (Meyer et al. 2007). The decomposition command is passed to the SCORM format plug-in of the repurposing framework for execution. At this point, the framework approach shows its strength: Other document formats could be supported as well by extending the framework without changing the modularization tool.

As part of the decomposition process, a metadata strategy is applied to create LOM metadata records for the new modules. Currently, a simple non-interactive metadata strategy is used. The method copies all fields of the original metadata record, which are supposed to remain valid, to the new module. A new title is set as described above. The application also captures some lifecycle information and writes them to the metadata record.

After the modularization process has been completed, the SCORM package has been transformed into an aggregate of modular Learning Resources. The resulting modules can also be exported separately and aggregated with different contents to new courses. The overall application also provides support for adapting the contents to a new learning or teaching context (Zimmermann 2006).

Evaluation

Meanwhile, the presented modularization tool has been developed and improved in the course of multiple project milestones. From a functional point of view, the implementation demonstrates that SCORM packages can be modularized and aggregated as designed by the modularization concept. It is possible to decompose Learning Resources, to aggregate the modular parts to new Learning Resources and to exchange them via the marketplace.

There has been a usability test recently to evaluate how normal users get along with the prototype. The number of participants is not enough for statistical relevance, but nevertheless allows some interesting conclusions. The users were given the Content Sharing module editor including the modularization tool and an adaptation tool, together with a user guide and a description of the test scenario. They were asked to modularize an existing SCORM package using the modularization tool.

The reactions from the users indicated – as assumed – that the usability of the prototype has yet a potential for improvements. Especially invalid user actions should be detected or prevented earlier.

However, the most important result of the usability test has been the identification of a new user group, the non-authors. Non-authors are users who are not educated for content authoring and therefore do not have a technological background, such as knowledge about SCORM, HTML or image formats. When the user group of reuse systems expands to also cover non-authors, new requirements for reuse tools arise. Modularization and aggregation have to become more intuitive. Technical details, such as the SCORM nomenclature, have to disappear or be replaced by colloquial language. New metaphors need to be found for enabling non-users to naturally handle these tools.

Conclusions

This paper has introduced a concept for interactive modularization of SCORM-based Learning Resources, which is based on a generic modularization process model. The user is guided through several process steps that lead to the modularization result. The main focus of the presented concept lies on an interactive boundary determination view. In this view, an outline of the Learning Resource is presented, combined with an assignment of target modules. The target modules are interactively proposed by the modularization tool, but can be afterwards changed by the user.

An actual implementation of the concept has also been presented. A usability test has pointed out, that a new target group for reuse tools has to be focused in the future. This target group consists of users who are not traditional content authors, but only want to recombine parts of existing contents for a new learning or teaching context. This

outcome can be seen as an analogy to the Web 2.0 trend, where formerly passive consumers become more active and participate in the creation of contents.

For the future, we plan to improve the modularization tool by providing better support to the user. This concerns mainly two aspects: content analysis and decision support. Further content analysis methods should produce more information about the contents of structural elements and thereby help the user to faster grasp the contents of a Learning Resource. And improvement of decision support aims at providing additional interactive methods for module boundary proposals. These methods could be, for example, selection and clustering of elements based on their attributes.

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Acknowledgements

This work is supported by the German Federal Ministry of Economics and Technology in the context of the project Content Sharing, cf. http://www.contentsharing.com.