

Another Brick in the Courseware or How to Create Reusable Learning Objects

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Abstract: This paper describes guidelines to identify and design reusable learning objects. The guidelines are the output of a project called eduBITE. Learning objects are treated as the smallest units of learning material development and reuse. General and specific technical and didactic learning object properties are specified. To support the learning object implementation process a WYSIWYG LO-Editor eduEDITOR has been developed. To index, store and retrieve LOs and to put them together to personified courseware a 'Computer Aided Courseware Design Tool' called eduWeaver is presented which has also been developed in eduBITE.

1. Introduction and Motivation

Today a lot of schools and universities offer Learning Management Systems (LMS) to their teaching staff to support their courses online. Although a lot of functions are made available by LMS the tasks to vitalize an 'empty' course and to develop and offer high quality learning online materials (courseware) often overcharge teachers as well in technical, temporal, didactical as in courseware engineering aspects. The development of good quality courseware demands further training of the teaching staff and is expensive and very time consuming. In spite of these high courseware production costs most materials are reusable only to a very small extent. Dependencies on LMSs and monolithic learning materials are the main reasons for suboptimal courseware quality, everything is 'self-made' and no reuse of existing courseware is done. Project results therefore often get lost.

Section 2 of this paper sketches eduBITE project which was the framework to define guidelines for LO development. Section 3 deals with the guidelines for the development of reusable learning objects (LOs) to create courseware more flexibly and presents eduEDITOR, a WYSIWYG LO editor considering the defined guidelines. To reuse LOs and build them together according to the respective requirements of the target groups the configuration tool EduWeaver was developed. This tool has the function of a virtual LO marketplace where teachers can search for reusable learning objects being supported by meta-data-structures. EduWeaver is sketched in section 4 of this paper.

2. EduBITE Project

EduBITE (www.edubite.ac.at) is one of 25 projects which were supported by the Austrian e-learning- initiative "New Media in Education" (www.nml.at). During the project reusable learning objects concerning selected topics of computer science were developed by 5 Austrian Universities.

2.1. Approach and Objectives

Within the eduBITE project reusable learning objects in the field of Integrated Business Information Systems (IBIS) were developed (Steinberger, Bajnai 2003). The project partners felt a high demand for learning materials focusing the understanding of integrated business processes in general on one hand and Enterprise Resource Planning System specific detailed knowledge on the other hand as well as the correlation of these two aspects. The fact that there existed different target groups to learn about IBIS showed that there was a need to design reusable and configurable courseware. eduBITE focused on the following objectives:

- To develop teaching materials
Topics relating to ‘Integrated Business Information Systems’ (IBIS) such as conceptual business engineering, enterprise modeling, the support of business processes implementation or the customization of ERP-systems are prepared for multimedia use based on a case study enterprise (DeBITE).
- To develop Instruments:
EduWeaver is developed as a tool to support courseware-design, in order to categorize developed materials according to the IEEE international meta-data standards, to structure course scenarios and to enable reuse. The meta-indexed learning objects can thus be used to design specific lessons according to special target groups or certain learning processes. These items guarantee adaptation, enhancement and interoperability of the developed multimedia material.
- To develop a Communication Platform:
The output of the project is aimed at to increase the reuse of available multimedia materials in the IBIS context. The association AKIT (www.akit.ac.at) will be the framework to obtain access to the multimedia materials and to improve and enhance them. Its members also constitute the market for the sustained use of the project products.

2.2. Architecture of eduBITE Environment

Within eduBITE a lot of reusable multimedia learning objects were developed. These learning objects focus on computer science students as well as business administration students. Using a tool called eduWeaver learning objects were meta-indexed and organized in a repository. Based on this repository courseware can now be designed modelling larger learning units (lessons, modules) flexibly out of learning objects. This enables a courseware configuration of the desired needs. A course can then be published and used in any learning management system understanding the interoperability standards IMS (IMS 2004) or SCORM (SCORM 2004). This guarantees adaptation, enhancement and interoperability of the developed multimedia material. The architecture of eduBITE is sketched in figure 1.

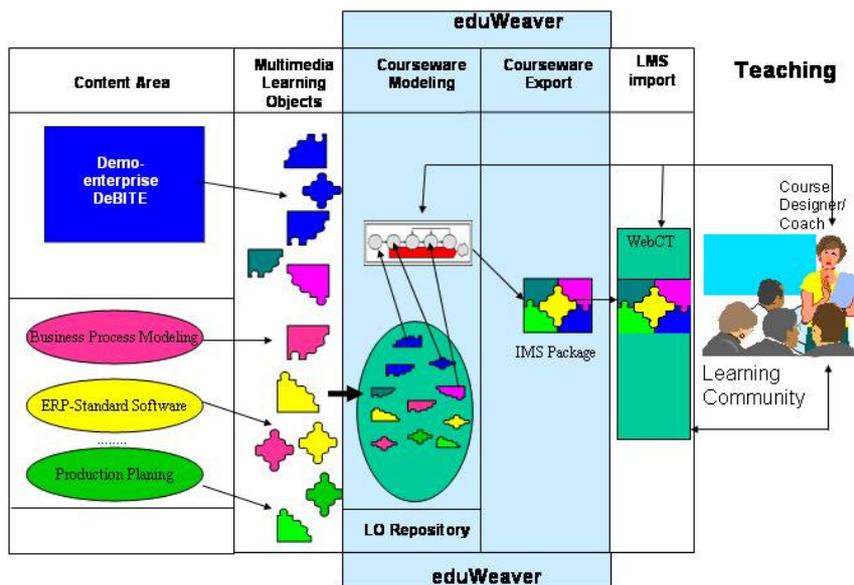


Figure 1: Architecture of the eduBITE e-learning environment

Within eduBITE about 200 Reusable Learning Objects have been developed. The lessons learned in eduBITE about 'how to create reusable learning objects' are independent of the respective content area. Section 3 tries to summarize the most important issues.

3. Reusability and E-Learning

Most process models for courseware development suggest to modularize courseware into small, self-contained units (Alderman, Barritt 2004) (Horton 2000) (Klein, Stucky 2001) (Cisco Systems 2004) and to reuse existing materials. Although these process models recognize that small learning units can later on be reused and composed to larger units very flexibly they neglect to detail the basic conditions for this modularization, the properties of reusable learning units and facts how reusability can be achieved in detail.

Following the object oriented paradigm learning units of finest granularity are called in eduBITE 'learning objects'. To keep the degree of reusability high learning objects in eduBITE are characterized by the following properties:

3.1. General Learning Object Properties

- A *learning object* is the smallest unit of reusability in eduBITE.
- A *reusable learning object* is a learning unit of high cohesion that aims at a certain learning objective. To fulfil this objective it aggregates different information objects (Mayer, Dorn 2004) like hypertexts, pictures, videos, documents, formulas, animations, audios, videos. Information objects themselves are not units of reusability in eduBITE.
- *Reusable learning objects* are low coupled. No references are to be made via hyperlinks to other learning objects to guarantee reusability. Only links to 'very reliable' URLs are allowed. How learning objects are to be used together in the context of a individual course can be made clear within a 'introduction learning object' that is not reusable.
- Each *reusable learning object* formulates a learning objective and a target group.
- A *reusable learning object* consists of multimedia content with an added value to printed texts. Additionally it offers the learner the possibility to self-evaluate the learning results interactively and defines tasks that enable the learner to apply the new knowledge (Cisco Systems 2004).
- The optimal learning time of one *reusable learning object* lies between 10 and 30 minutes.
- Each learning object has to be meta-indexed (e.g. creation date, keywords, language, author, software/plugin, learning time, target group,...).

3.2. Didactic and Technical rules

Learning object properties of chapter 3.1 are necessary for the identification of learning objects but not sufficient for their final design. To guarantee as well a common look and feel as the orientation on didactical principles *technical templates* and *didactic rules* have to be developed (Mayer, Dorn 2004).

Learning objects have to be independent knowledge stores. They should neither need a special LMS nor a special server technology. Within eduBITE they have been realized as dynamic and client based html-pages. By this way server independent distribution, import into different learning management systems and offline use of learning objects are enabled.

The eduBITE technical template contains defaults how to realize the navigation, colour design, text design, integration of pictures, audios, videos, animations, references and the glossary in form of a style sheet.

Technical eduBITE templates are supplemented by the following didactic rules :

- A reusable learning object has an overview page, from 3 to 8 content pages, a page with references and a glossary page
- A content page should not exceed 2 vertical screen pages. Horizontal scrolling is to be avoided.

- Each reusable learning object should introduce and motivate at the beginning and summarize at the end the learning object message.
- Each learning object owns a navigation bar to access pages directly
- The ‘message’ of a reusable learning object has to be printable.
- Some metadata (e.g. author, creation date, target group, keywords) have to be accessible to the learner.
- The expenditure of time to master one learning object has to be made clear to the learner.
- Realizing learning objects the medium ‘computer’ has to be used in an optimal way and additional values compared to printed texts should be recognizable.

Learning objects that have been developed in accordance with these guidelines can be found in www.edubite.ac.at. To enable teachers a comfortable implementation of reusable learning objects without demanding a teacher special computer language skills eduEDITOR was developed, which is sketched in the following section.

3.3. eduEDITOR – a Learning Object Editor

eduEDITOR is a WYSIWYG tool that supports the implementation of reusable learning objects following a set of design guidelines defined in eduBITE project. It separates learning object content and layout, demands no programming knowledge and guarantees a certain didactic quality of a learning object. eduEDITOR is based on XML and provides an easy approach to create and edit learning objects. eduEDITOR is completely written in C# and runs – at this point in time – on Windows based machines with the .NET Framework 1.1 installed. Figure 2 shows the GUI of eduEDITOR:

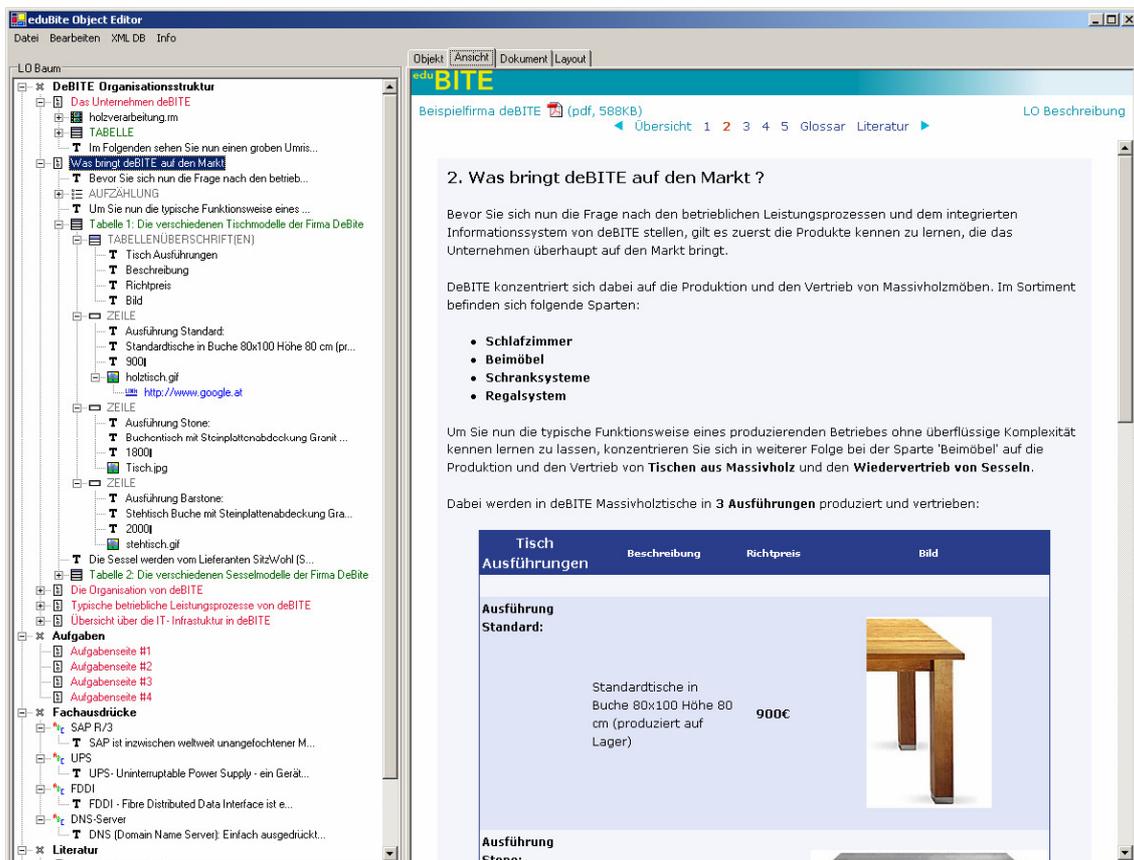


Figure 2: The eduEDITOR interface

eduEDITOR was developed to enable non computer specialists to implement good quality learning objects. Being based on eduBITE design guidelines eduEDITOR ensures a certain technical and didactic quality level of learning objects. Content is stored separately from its layout that also makes content customizable to a certain extent and raises so the reusability. eduEDITOR indexes learning objects with metadata and can export them into HTML files or SCORM packages. eduEDITOR is completely written in C# and is tested on Windows OS based machines. The editor runs locally as a single application demanding the .NET Framework as prerequisite.

With eduEDITOR the user is able to edit, load and store XML files based on the eduBITE document type definition (DTD). A main feature of eduEDITOR is the possibility to export learning objects into a standardized SCORM package.

The interface of eduEDITOR is divided in two main areas (Fig. 2). On the left side the learning object tree is rendered from the learning objects corresponding XML document, on the right side are four sections for editing data within the learning object, viewing the output HTML, going through the XML document itself and for changing graphical issues via CSS (Cascading Style Sheets).

To create good quality learning objects is necessary but not adequate to achieve their reusability. They have also to be retrievable very flexibly. By the means of eduWeaver, a ‘Computer Aided Courseware Design Tool’ that has been developed within eduBITE, learning objects can be meta-indexed by their authors and stored in a central eduWeaver repository. Via this repository they are accessible for reuse now. To support learning object reuse eduWeaver offers a graphical description language similar to business process modeling languages to conceptually model courseware. Using eduWeaver learning processes can be described in a very simple manner and learning objects are integrated from the repository into models of learning processes. In the following section eduWeaver will be introduced in more detail.

4. eduWeaver – A Computer Aided Courseware Design Tool

EduWeaver is a tool to store meta-indexed learning materials in a repository called ‘content pool’ and to support their easy reuse within the design process of courseware. Currently the eduWeaver content pool contains only eduBITE learning objects. Via an online, browser-based interface any teacher in Austria has an access to eduWeaver, where currently over 200 reusable learning objects are stored. Not only the learning objects themselves but already designed lessons, modules or even whole courses might be searched for and reused at an other university or within an other course. In order to allow the easy handling of the learning objects and the didactically designed reusable structures a graphical modeling interface was implemented.

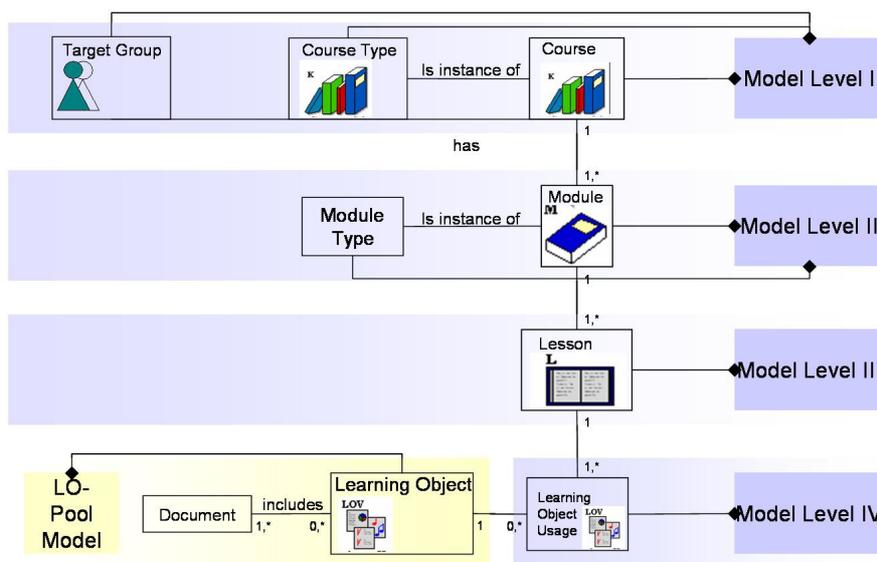


Figure 3: The 4 modeling levels of eduWeaver

Courseware modeling with eduWeaver happens on four modeling levels. The modeling levels contain learning units that correspond to the model types *Course*, *Module*, *Lesson* and *Learning Object Use* (see figure 3). These model types are hierarchically linked to each other by internal references. Within each modeling level intended learning processes can be graphically modeled using according object and relation classes representing different granularities of the process level.

The *Course Level* gives a graphical overview of all provided courses. On this modeling level there are no sequences or interdependencies, since it is hierarchically the highest level and should give a starting point for the designer. *Module Level* allows to plan the course in detail modeling the learning process step by step. Here the order of coherent modules within one specified course is defined.

An example is shown in figure 4. This figure also gives an impression of the GUI of the tool.

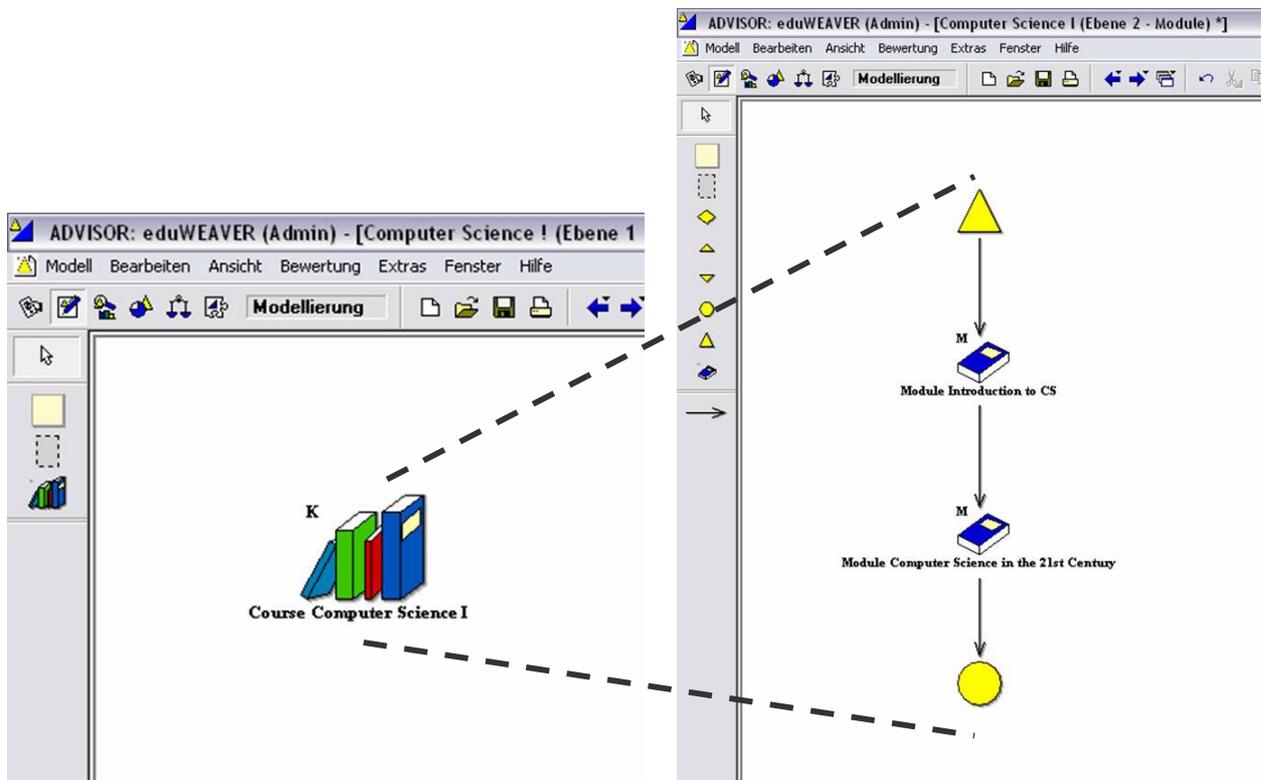


Figure 4: Example model of Course and Module Level

The *Lesson Level* breaks down one module into a detailed view, that allows the ordering of topics or time frames within one module and so the detailed design of lessons.

On *Learning Object Use Level* lessons are detailed and teachers can directly access and use the content pool that provides a graphical overview of all existing learning objects. EduWeaver provides a sophisticated search engine in order to easily find matching learning objects within the content pool. Each of the modeled objects on the fourth level references to one or more learning objects in the content pool. These learning objects can be easily viewed by using the innovative functionality of eduWeaver *learning process stepper* in order to enhance user friendliness.

The left hand side of figure 4 gives a simple overview of how a model on level III might look in eduWeaver. This model describes what happens in one module of a specific course. The example has a starting point defined by a triangle. Then 2 lessons follow in a sequence. Then an example of a parallel is shown here, it is the case for example when students have a practical lesson supported by online materials about the theoretical background. Then the module ends which is marked by a circle.

On the right hand side of figure 4 the level of Learning Object Use is shown, which is a detailed view into one lesson, modeled on level III, as shown on the left hand side of figure 4. Level IV also has a starting point, which is followed by 2 learning objects before the lesson ends. This figure also gives an impression how the hierarchical interdependencies between the modeling level is meant.

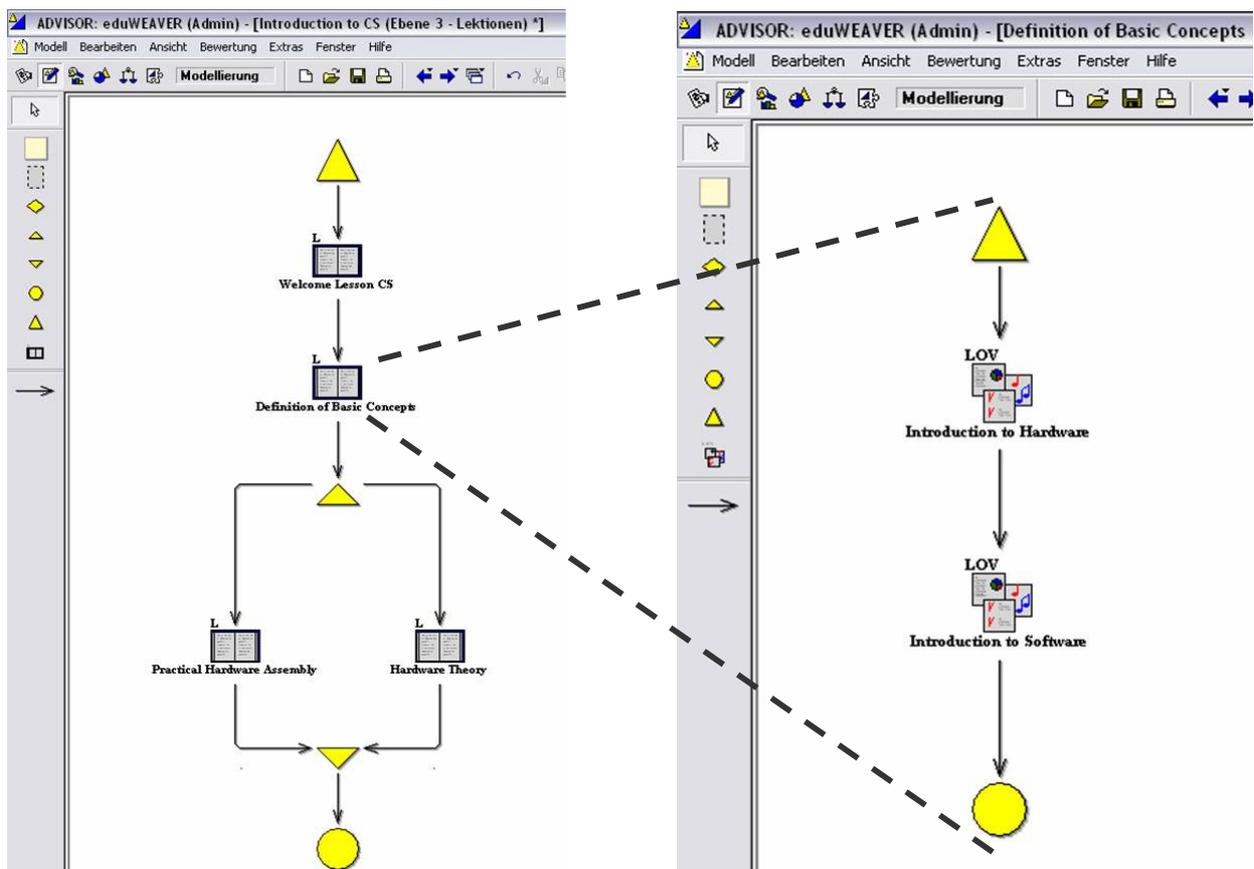


Figure 5: Example models for Lesson and Learning Object Use Level and their Interdependency

After having modeled individual courseware with eduWeaver the complete courseware structure including the learning object documents can be exported through an XML-interface into IMS or SCORM content packages and then imported into any IMS or SCORM compliant Learning Management System. These specifications provide the functionality to describe and package learning materials, such as an individual course or a collection of courses, into interoperable and distributable packages.

5. Resume

The availability of reusable learning objects together with adequate tool support makes it easier for teachers to develop high quality courseware in passable time. Time and money are better invested for the development of reusable learning objects than for learning materials that are usable only one-time. This paper describes guidelines to develop reusable learning objects. EduEditor and eduWeaver are Tools that can be used to support flexible courseware modelling, learning object implementation and reuse.

6. References

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