

A Solution for Courseware Reuse in the Web-Based Distance Learning System

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Abstract: *This article discusses important problems of information structure design in distance learning systems and the possibility of designing multiple courses from existing educational materials.*

The paper adopts a two-phase methodology embodying in itself the development for/with reuse phases. The article discusses how the two phases can take place in the information structure of a database and the courseware development process. All conclusions are received by sketching the distance learning environment currently under development of the Web-based distance learning system FLAME.

Key words: *Information Systems, Distance Learning, Courseware Reuse, Learning objects.*

INTRODUCTION

In this article, we discuss the impact of courseware reuse in the course development process. The strong motivation behind this study arises from two issues: first, the need to decrease the human resources needed to develop learning materials, and second, the increasing availability of courseware produced within research projects (e.g. ARIADNE Project [2] as well as by international organizations (e.g. ADL [3] and IEEE LTSC [4])

As it is a common practice in the software engineering field, the reuse is divided into two phases – “development for reuse” and “development with reuse” [1]. The first phase deals with the process of creating reusable components. The second phase provides the tools needed to retrieve the components and for their integration into the software system being developed. In the first phase the adoption of an **abstract representation** of the components assumes a **strategic role**, while in the second the main focus is on having components which can easily be **adapted** and then **integrated** into the new product (for example “education course”).

These two phases are described separately, since they take place in different development stages, but they are logically related. In fact, the experience gained in trying to reuse components comes in very useful in producing them.

The first contribution of this article is a discussion of the two previously mentioned phases as part of the **courseware** reuse process. More precisely, this paper concludes that the phase “development for reuse” needs an adequate **data model**. In regards to this we present a data modelling structure, which is based on the terms “learning object” and “learning units”.

As mentioned above, the “development with reuse” phase needs tools that can support the retrieval and integration of existing learning materials in the course being developed. This article describes a mechanism, which has been used for course generating in the Web-based Distance Learning Environment FLAME [5, 6].

COURSEWARE REUSE

The courseware reuse live cycle includes two phases. The first, named **Development FOR Reuse** involves the design of reusable courseware to be used later in the development of similar courses within a specific domain. The second, named **Development WITH Reuse**, deals with the construction of courses satisfying specific requirements by (re)using existing components from a courseware database (Local Repository) or taken from the Web. The first is an evolutionary task, which uses the experiences acquired in the second stage of reuse. The reuse life cycle is shown on Figure1.

The following key activities can be identified in connection with the **Development for reuse** phase:

1. **Qualification and generalization**, where a component is qualified for reuse by evaluating its content, usefulness and quality, and then generalized by a particular abstraction mechanism;
2. **Classification**, where components are catalogued in a Local Repository for later retrieve.

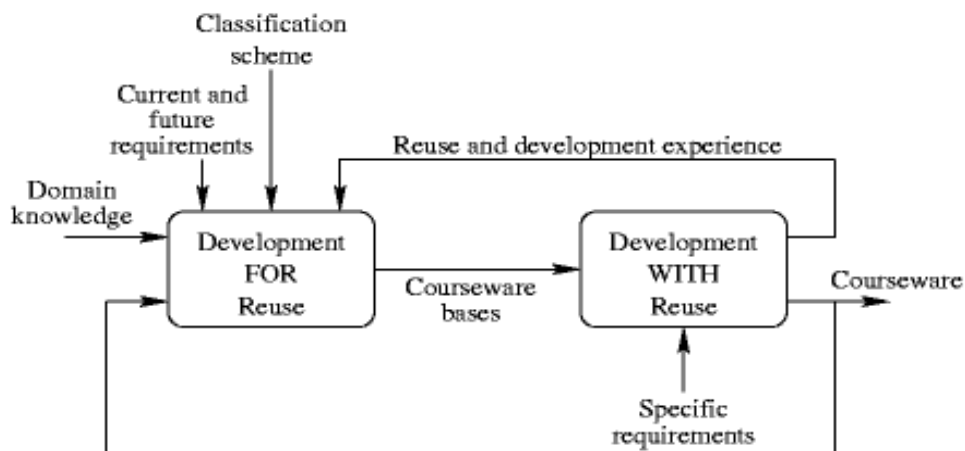


Figure 1: The reuse life cycle

In regards to the **Development with reuse** phase, three different key activities can be identified:

1. **Retrieval** - in which courseware bases (Local Repository and Web) are searched for potential reusable components (satisfying specific requirements);
2. **Understanding and adaptation** - where a retrieved component, satisfying specific requirements, can be reused as a black box to customize it to the particular needs of a course;
3. **Composition** - where the retrieved components, adapted for reuse, are assembled to build more complex courses.

The philosophy of courseware reuse is based on the two main terms “**learning object**” (LO) and “**learning unit**” (LU).

“**Learning object**” is the smallest learning material that is atomic, in the sense that it describes a single concept and is presented by one type of data. Learning object can represent a textual item, an exercise, graphical or sound material, or a set of test questions, based on a single learning concept. Usually the learning object is presented as a single file in a known data format. More often it is an XML-format.

A “**Learning Unit**” (LU) is a standalone piece of knowledge, which includes all the data needed to satisfy a specific educational goal. It includes a combination of learning objects and can be considered equivalent to a standard lesson or a module of several lessons.

Our concept for the content of the **learning unit** is based on the knowledge paradigm “theory, practice, assessment”. This means that each learning unit must include all three types of educational materials. A similar concept is used by Cisco systems for developing lessons for their online Cisco-academy.

A regular teaching lesson is used as an example of a basic learning unit. There are two reason for this: first, it corresponds with the structure of educational programs, so it facilitates the authors (teachers and professors) in presenting their educational concepts, and second, it supports the flexibility and mobility of learning units, and the easy actualization of the knowledge resources base [5].

The meta-model of basic learning units is shown on Figure 2.

For the purposes of the second phase of courseware reusability and to facilitate searching in the Local Repository the learning units are organized into sections (bigger learning units).

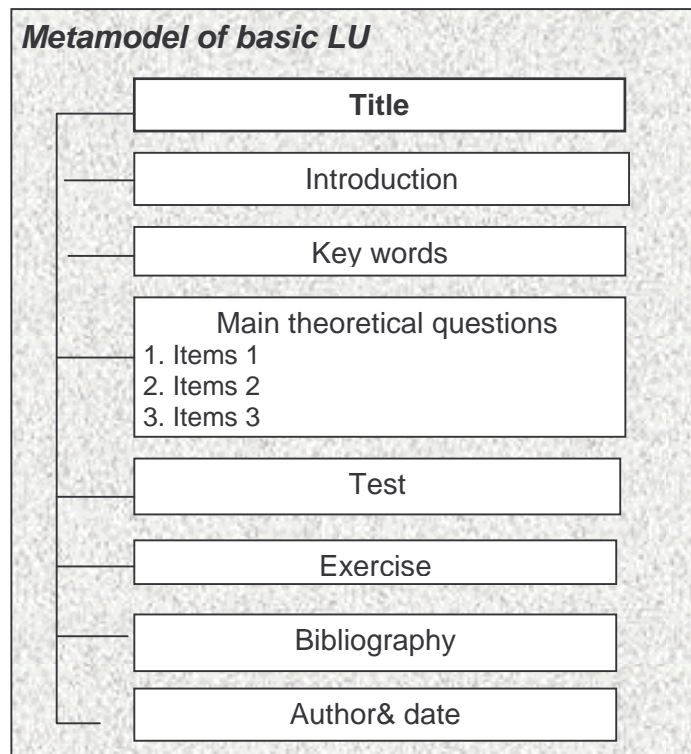


Figure 2: Metamodel of basic Learning unit – lesson

The sections are equivalent to learning modules, and the modules are organized in knowledge domains (usually called disciplines). This hierarchical structure supports **classification and generalization of learning objects**. In fact, the courseware database is a meta-model of the Learning Object's Repository as presented on Figure 3.

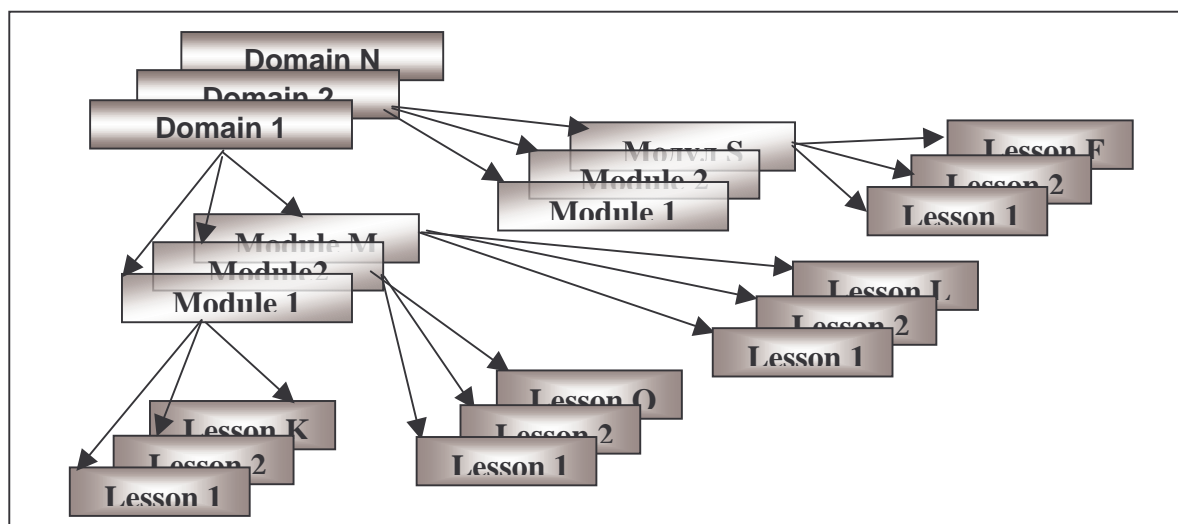


Figure 3: Meta-model of Local Repository

By storing learning objects in this manner and by using a specific meta-model of learning units we can combine different learning units and generate different educational courses.

METHODOLOGY OF REUSE COURSEWARE

We have developed a courseware development methodology, which merges the two phases of development for/with reuse mentioned above. It is described by the following algorithm:

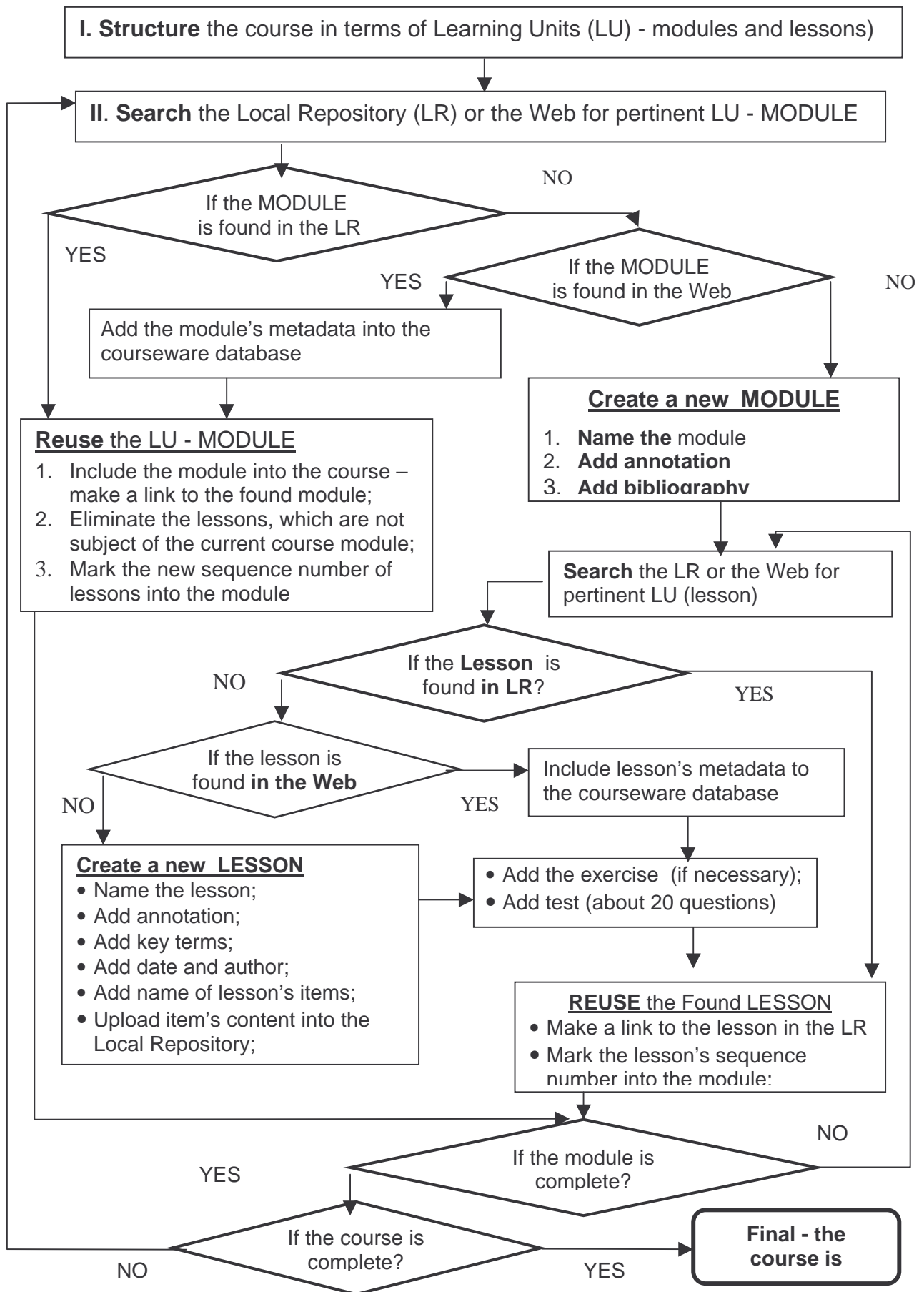


Figure 4: Methodology of reuse courseware for distance learning

The first step of the methodology structures the course in terms of learning units, while the second performs both phases of reuse. The development with reuse requires searching both the Local learning unit repository and the Web looking for the appropriate Learning Unit. First we search for a bigger LU (module), because it is a main structural element of the newly generated course. If an appropriate module is found in the Local Repository, it can be reused. We analyze the module and have the option to remove or add additional lessons based on the learning goal. If a pertinent module is not found in the Local Repository, but is found in the Web, we must convert its content and include it in the Local Repository and then include its metadata into the courseware database. Finally, we can include it into the newly developed course by adding a link to the Local Repository. If a pertinent module is not found, a new one must be created from scratch. The search for learning units (modules and lessons) continues until the course is completed. As an example of a final task (the development for reuse step), the methodology assumes that each learning unit found/created is added to the repository for later reuse.

REALIZATION OF METHODOLOGY

We integrate the methodology described above into the development of Web-based Distance Learning System FLAME. For this goal we use the following software tools:

MySQL database server is used for storage and management of learning units. PHP is used for data mining (searching, converting, generating and presenting learning units to the users.)

FLAME gives authors useful tools for creating reusable learning units (lessons and modules) and facilitates the uploading of learning object into the Local Repository and adding or editing all learning units metadata. An example of the user interface for creating and editing learning unit modules is shown on Figure 4.

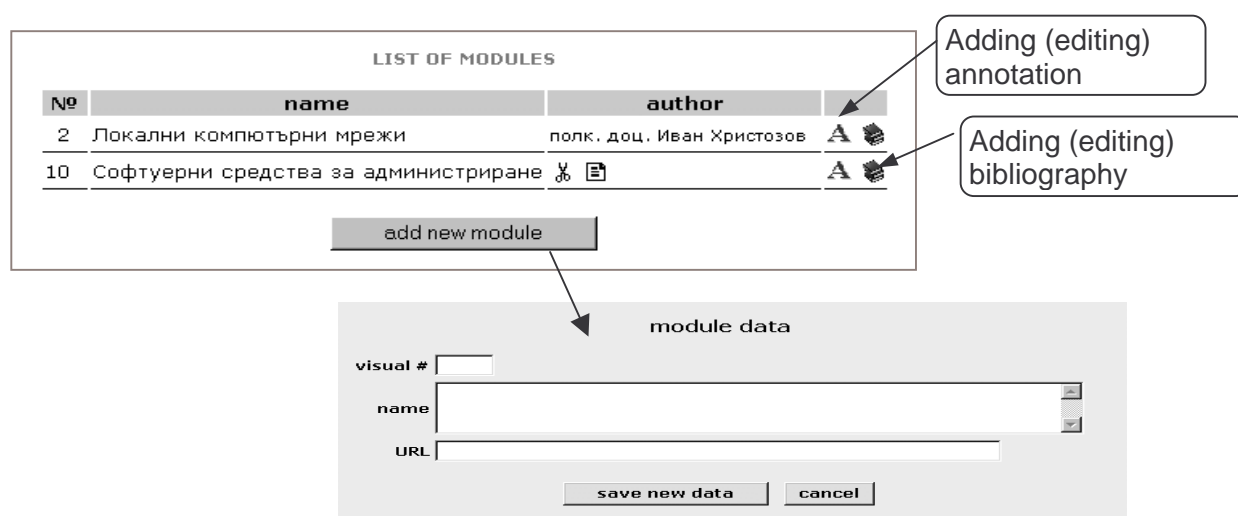


Figure 5: Creating a reusable Learning unit “module” in FLAME

Every module is made up of lessons, whose meta-model is presented on Figure 2, and the user interface for their creating and including into the LR is shown on Figure 6.

As mentioned above, the phase of “development with reuse” needs tools, which can support the retrieval and integration of learning material into the course being developed. To facilitate course development, FLAME provides the course designer with tools, which allow him to choose appropriate modules from the Local Repository (if it exists), select the appropriate lessons and change their sequence within the module. If the module does not exist in the Local Repository the course designer can create it, and then search for appropriate lessons and include them in the module.

An interface for generating course from reusable Learning units is shown on Figure 7.

science Автоматизирани информационни системи-АИС

SCIENCE COURSES GROUPS QUESTIONS MAIL MESSAGES SCHEDULE PASSWORD CATALOG HELP EXIT

SUMMARY MODULES AUTORS DICTIONARY

module 1. ЛОКАЛНИ МРЕЖИ

LIST OF TOPICS

№	name	author	test
10	1. Локални мрежи - основни понятия created 01/23/03 modified 10/03/03	полк. доц. Иван Христов	35
20	2. Свързване на мрежовите компоненти created 01/30/03 modified //	полк. доц. Иван Христов	1
30	3. Администриране на мрежите created 01/30/03 modified 07/14/03	полк. доц. Иван Христов	1

add topic

Annotation
Keywords
Bibliography
Tests
Exercise

Figure 6: Creating basic Learning units – lesson

course 2510 Администриране на компютърните мрежи

SCIENCE COURSES GROUPS QUESTIONS MAIL MESSAGES SCHEDULE PASSWORD CATALOG HELP EXIT

SUMMARY MODULES KEYWORDS

to normal mode

list of modules	test	topics	visual #
1. Локални мрежи дисц.Автоматизирани информационни системи-АИС	2 от 3	0	>
choose which topics to be included		author	
<input type="checkbox"/>	1. Локални мрежи - основни понятия	гл.ас. Стефка Ненова	
<input checked="" type="checkbox"/>	2. Свързване на мрежовите компоненти	полк. доц. Иван Христов	
<input checked="" type="checkbox"/>	3. Администриране на мрежите	гл.ас. Стефка Ненова	
2. Софтуерни средства за администриране дисц.Администриране на мрежи	1 от 2	2	>

add new module

Figure 7: Composing a course by reusing the existing Learning units

CONCLUSION

This two-phase methodology ensures efficient use of human resources, easy support of the Learning Repository, and easy generation of various educational courses.

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