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REENGINEERING OF LEARNING CONTENTS FOR NEW E-LEARNING SYSTEM BASED ON LEARNING OBJECTS AT THE BELGRADE METROPOLITAN UNIVERSITY

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Abstract: *The paper describes how BMU has reorganized its programs, e-learning methodology and technology in order to implement its new e-learning strategy which aims to the personalization of e-learning. The first step in this direction is to implement the concept of using fine grain learning objects, to create a repository of learning objects that is used for configuring personalized online lessons. The paper presents the first, foundation stage of creating learning contents in the form of fine grain learning objects and setting the process of selection of learning objects to create online lessons. The described approach is implemented for creation of all courses of BMU bachelor programs.*

Keywords: *E-Learning, Learning objects*

1. INTRODUCTION

Almost all bachelor and master programs at Belgrade Metropolitan University (BMU) have been offered both in-class and online since 2005. About 60% of students have been studying using the online option. Typically, an online lesson has been providing a Power Point presentation with narration and lecture notes in PDF format. Depending of the course, students have been receiving, as an exercise, solved problems and problems that they have to solve. Also, they have been receiving mostly weekly or bi-weekly assignments, and one project assignment for each course.

Experience gained after using e-learning for eight years now, directs changes in order to

- increase student interactions and activities during e-learning sessions;
- implement more problem-oriented learning;
- support personalized e-learning; and
- increase the reusability of learning content, when it is necessary, as it reduces costs of preparing learning contents, and can improve their quality.

These goals may be achieved only if an integral approach to the development of a new e-learning framework is implemented. It should include:

1. new organization of learning contents based on fine grained learning objects,
2. appropriate e-learning methodology, and
3. new e-learning technology that supports learning objects and new e-learning methodology.

This paper[1] focuses on components 1 and 2, i.e. describes the strategy of implementation of learning objects (LOs) and new e-learning methodology at BMU. BMU will start using this new e-learning framework from 1st of October 2013, i.e. in all bachelor programs of academic 2013/14

2. ORGNIZATION OF KNOWLEDGE AND LEARNING OUTCOMES OF A CURRICULUM

A curriculum identifies the knowledge, skills and capabilities that all students of a program must possess. So, each program has its curriculum, and its body of knowledge that must provide to its students. What is the body of knowledge? There are many definitions of the body of knowledge. We cite few of them:

- "Body of Knowledge (BOK or BoK) is a term used to represent the complete set of concepts, terms and activities that make up a professional domain, as defined by the relevant professional association. ...It is the accepted ontology for a specific domain." (Wikipedia)
- Body of Knowledge is a "domain of essential information, mastery over which is required for success in a field or profession." (BusinessDictionary.com)
- A body of knowledge is: 1. 'a' source of information and best practices, 2. comes from a multitude of credible sources, 3. more than the sum of its parts, 4. provides a wealth of opportunities for individuals, 5. provides networking capabilities, 6. the opportunity to share ideas and concepts, 7. the opportunity to

[1] This paper provides some results obtained by the project with code III44006 financed by the Ministry of Education, Science and Technological Development of Republic of Serbia

always improve at the individual and organizational levels, 8. continually evolving (The Oxford Dictionary).

For us, a *Body of Knowledge (BoK)* specifies a structure of knowledge, skills and learning outcomes that a program must provide. The required knowledge is structured in three hierarchical levels: knowledge areas (KA), knowledge units (KU) and topics (in one or two tiers, for core and optional topics), as shown in Fig. 1. A topic specifies a basic concept or a fine grain knowledge needed to accomplish an elementary task or to understand a term.

The granularity of topics may be different, and they may be organized in their own hierarchies, but if they are implemented, they usually have just two levels*: topics* and *sub-topics*. Topics may also be divided to *core topics*, that all students need to know, and *optional topics*, that are recommended, but are not obligatory for all students. Figure 1 shows one such case, where tier-1 topics represent, in principle, core topics, and tier-2 refers to optional topics.

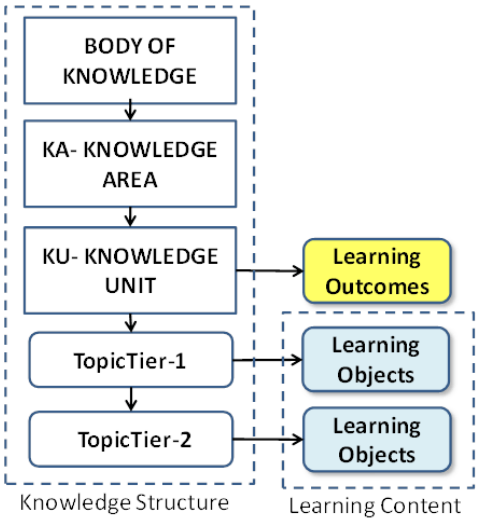

Figure 1: The structure of a Body of Knowledge

A *knowledge unit* (KU) consists of a set of topics that describe a more complex concept or a set of interrelated concepts that specify a chunk of knowledge that provides students one or more basic professional capabilities. These are learning outcomes, as the specify what students are capable to do, in a professional context, when they learn and acquire knowledge units.

A *knowledge area* (KA) consists of a set of knowledge units covering a specific but broad area of knowledge. For instance ACM&IEEE [1] specified *Computer Science BoK*: with the following knowledge areas:

1. AL - Algorithms and Complexity
2. AR - Architecture and Organization
3. CN - Computational Science
4. DS - Discrete Structures
5. GV - Graphics and Visual Computing
6. HCI - Human-Computer Interaction
7. IAS - Information Assurance and Security
8. *IM - Information Management*
9. IS - Intelligent Systems
10. NC - Networking and Communications
11. OS - Operating Systems
12. PBD - Platform-based Development
13. PD - Parallel and Distributed Computing
14. PL - Programming Languages
15. SDF - Software Development Fundamentals
16. SE - Software Engineering
17. SF - Systems Fundamentals
18. SP - Social Issues and Professional Issues

For instance, *IM-Information Management* knowledge area consists of the following knowledge units:

1. *IM/Information Management Concepts*
2. IM/Database Systems
3. IM/Data Modeling
4. IM/Indexing
5. IM/Relational Databases
6. IM/Query Languages
7. IM/Transaction Processing
8. IM/Distributed Databases
9. IM/Physical Database Design
10. IM/Data Mining
11. IM/Information Storage And Retrieval
12. IM/MultiMedia Systems

For instance, *IM/Information management Concepts* knowledge unit consists of the following topics:

1. Information systems as socio-technical systems
2. Basic information storage and retrieval (IS&R) concepts
3. Information capture and representation
4. Supporting human needs: Searching, retrieving, linking, browsing, navigating
5. Information management applications
6. Declarative and navigational queries, use of links
7. Analysis and indexing
8. Quality issues: Reliability, scalability, efficiency, and effectiveness

Topics 1-4 are in tier 1, and topics 5-8 are in tier 2.

IM/Information management Concepts knowledge unit provides students with the following learning outcomes:

1. Describe how humans gain access to information and data to support their needs [Familiarity]
2. Understand advantages and disadvantages of central organizational control over data [Assessment]
3. Identify the careers/roles associated with information management (e.g., database administrator, data modeller, application developer, end-user) [Familiarity]
4. Compare and contrast information with data and knowledge [Assessment]
5. Demonstrate uses of explicitly stored metadata/schema associated with data [Usage]
6. Identify issues of data persistence for an organization [Familiarity]

7. Critique/defend a small- to medium-size information application with regard to its satisfying real user information needs [Assessment]
8. Explain uses of declarative queries [Familiarity]
9. Give a declarative version for a navigational query [Familiarity]
10. Describe several technical solutions to the problems related to information privacy, integrity, security, and preservation [Familiarity]
11. Explain measures of efficiency (throughput, response time) and effectiveness (recall, precision) [Familiarity]
12. Describe approaches that scale up to globally networked systems [Familiarity]
13. Identify vulnerabilities and failure scenarios in common forms of information systems [Usage]

Learning outcomes 1-6 are provided by tier 1 topics, a others – by tier 2 topics. Learning outcomes may refer to different depths of knowledge. In [1], they are called "mastery levels", and the following three mastery levels are used:

1. *Familiarity:* The student understands what a concept is or what it means. This level of mastery concerns a basic awareness of a concept as opposed to expecting real facility with its application. It provides an answer to the question "What do you know about this?"
2. *Usage:* The student is able to use or apply a concept in a concrete way. Using a concept may include, for example, appropriately use of a specific concept in a program, use of a particular proof technique, or performing a particular analysis. It provides an answer to the question "What do you know how to do?"
3. *Assessment:* The student is able to consider a concept from multiple viewpoints and/or justify the selection of a particular approach to solve a problem. This level of mastery implies more than using a concept; it involves the ability to select an appropriate approach from understood alternatives. It provides an answer to the question "Why would you do that?"

The learning outcomes shown above refer to different mastery levels (given in the square brackets).

BMU offers eight bachelor programs (Fig.2) with courses belonging to different domains. BoK of each program consists of parts of few domain BoK, with one that is the principle (shown with ticker arrows in Fig.2). Each course covers the knowledge from one of the domain BoK. As there are many courses that are part of different programs, their knowledge contents are specified only once, in one of the domain BoK.

This organization of knowledge provided by all bachelor programs at BMU avoid redundancies in knowledge specification related to different programs. One chunk of knowledge is specified only in one place, i.e. in one domain BoK. It allows easier updates of study programs and the knowledge they provide, as the knowledge that need to be updated is specified in only one place.

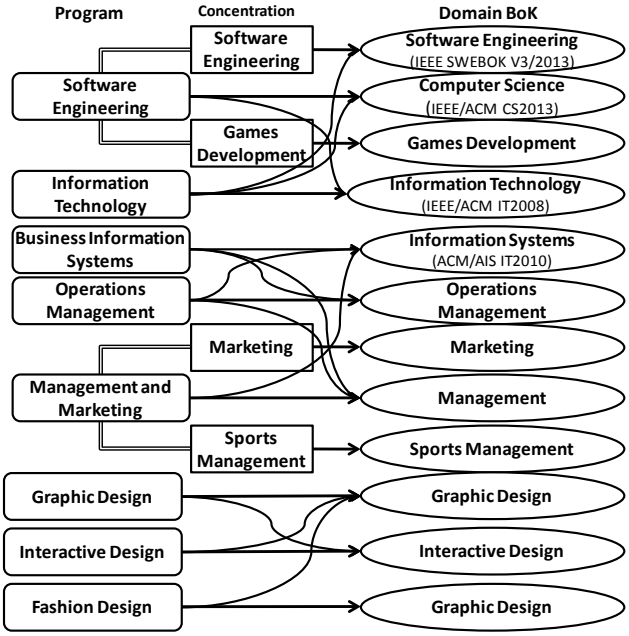

Figure 2: Programs and used domain BoK

3. USE OF LEARNING OBJECTS

We can think of a BoK as a tree with leaves representing Learning Objects (LOs). *Learning Objects* are defined here as any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning, as defined by IEEE. Reusability of learning objects increases as their granularity decreases [2,3,4].

The second reason to deal with fine grain learning objects, is the personalization [5]. With fine grain learning objects, it is easier to create personalized online lessons, as they can respond better to the needs of a student. So, at BMU, learning objects of fine granularity are to be used.

Fine granularity of learning objects increases their reusability and ability for personalization of e-learning, but it causes more difficulties in cataloguing of learning objects, as the repository of learning objects may have tens of thousands of learning objects. How to find a needed learning object? Besides using different searching technologies, it is possible to use the known taxonomy - BoK. If users of the repository of learning objects know the structure of the BoK they use, it is not difficult to develop a software module that will allow user to access the required learning object by navigation along the BoK tree. For each selected domain BoK, the software shows its structure. The user has to point out the pathway leading to the requested learning object, or a group of learning objects (LOs).

Based on the chosen path, the software generates the "path code" showing the acronyms of components of the BoK selected (Fig. 3). It is analysed by the access software, before the software finds and delivers the requested LO. By using navigational access to learning objects, a user does not need to know the title of the object he is looking for. It is enough that the user selects a

path to a topic in a BoK, and the system will show all learning objects related to the selected topic. As BoK topics are usually more general then topics of fine grained learning topics (LO topics), in most of the cases, a BoK topic will be related with few or more LO topics.

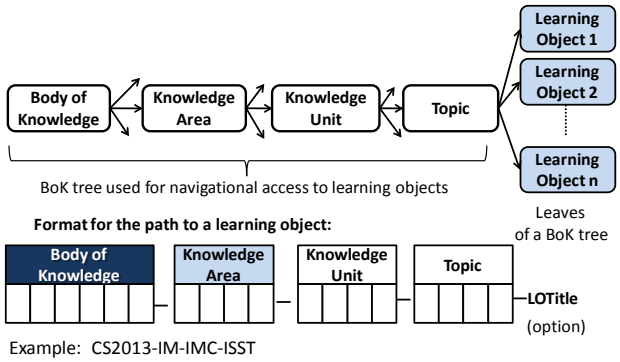

Figure 3: The structure of a BoK and the format of the path to LO

Learning objects are carriers of learning contents and they provide the knowledge that students have to learn. Fine grain learning objects, as used at BMU, give a small chunk of knowledge needed to describe phenomena or solve a small problem. BMU is using QDITA LO authoring tool [6] and Fig. 4 shows its structure of a learning object.

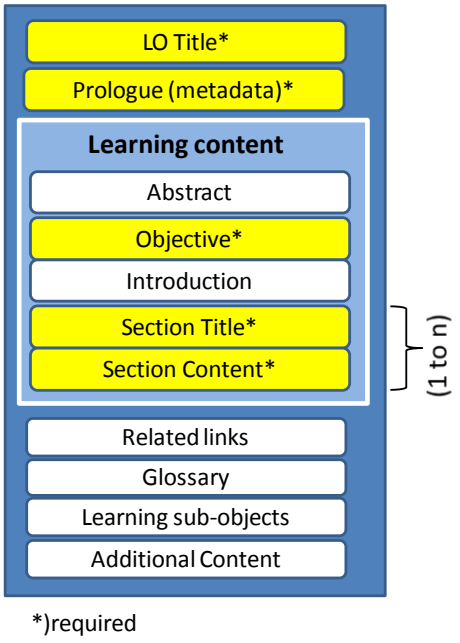

Figure 4: The structure of a learning object

Author of a learning object has two options for entering the content of a learning object:

1. Use of QDITA LO Editor
2. Use of LO template (a MS Word document with forms to be filled)

The short description of QDITA learning object sections used at BMU is as follows:

LO Title: The title is related to the concept(s) described in its content.

Prologue contains information necessary for LO search and retrieval. It contains the following attributes:

1. *Author:* Author's first and second name
2. *Categorization*: The path to the LO from BoK
3. *Difficulty level:* Specifies the difficulty level of the learning content - Elementary, Basic, Advanced, Innovative
4. *Keywords:* One or more relevant keywords, separated by comma
5. *Audience:* BS Student, BS&MS Student, MS Student, PhD Student, External course participant
6. *Learning duration:* The estimated duration of reading of LO in minutes
7. *Author's comments:* Any comments which explain the usage of the Learning Object to other authors and users

The main part of a learning object is ***Learning Content.*** It contains the following attributes:

1. *Abstract:* A short description of the Learning Object
2. *Objective:* The learning objective which should be in accordance with learning outcomes defined in the knowledge area or knowledge units to which the object belongs
3. *LO Introduction:* Introductory remarks about the Learning Object
4. *Section Title:* Title of the Section 1. Section Title and Section Body always go in pairs, and can be repeatable. Section Title should correspond to the Section Body. Learning Object must contain at least one Section. Additional Sections can be added for the purpose of visual separation of examples, references, and other specific contents.
5. *Section Body:* Body of the Section, which can contain paragraphs, images, figures, formulas, links to external resources (PDFs, zips, multimedia files, programming source code,...

Related Links: Provides descriptions and URL to interesting sites

Glossary: Lists of terms used in LO and their explanation

Learning Sub-Objects: Title-Body pairs used to add learning sub-objects, such as: use cases, step-by-step procedures, reference list etc.

Additional Content: An optional Title-Body pair containing the content that has not been included in previous sections.

Besides learning objects that refer to lectures, learning objects may represent problems used for exercises, tutorial and other additional learning contents.

If templates are used, all filled template files and files containing additional assets (such as figures, codes, multimedia records etc) are put together in a zip file. All these files follow the implemented naming convention (Fig. 3): BoK-KA-KU-Topic-LOTitle. Asset files contains an additional name after a "-".

4. CONFIGURATION OF AN ONLINE LESSON

An online lesson contains selected learning objects and interactive and supporting activities offered by the systems used at BMU – QDITA [6] and LAMS [7]. Introduction and Conclusion objects are specific learning objects created in the context of a specific lesson. Lesson designers (professors) search and select needed learning objects, and add interactive and supporting activities offered by LAMS subsystem of the BMU e-learning system (Fig.5). Interaction activities allow students to interact with the professors and assistants (Consultation, Q&A, File Transfer, Note, Wiki), with other students (Q&A, Forum, Note, Wiki), assess their understanding of the learning content (Personal Test) and express their opinions (Forum, Voting). Supporting activities, such as Picture Gallery, Picture Editor, MindMap, Table, allow professors and students to express their ideas and to present each others.

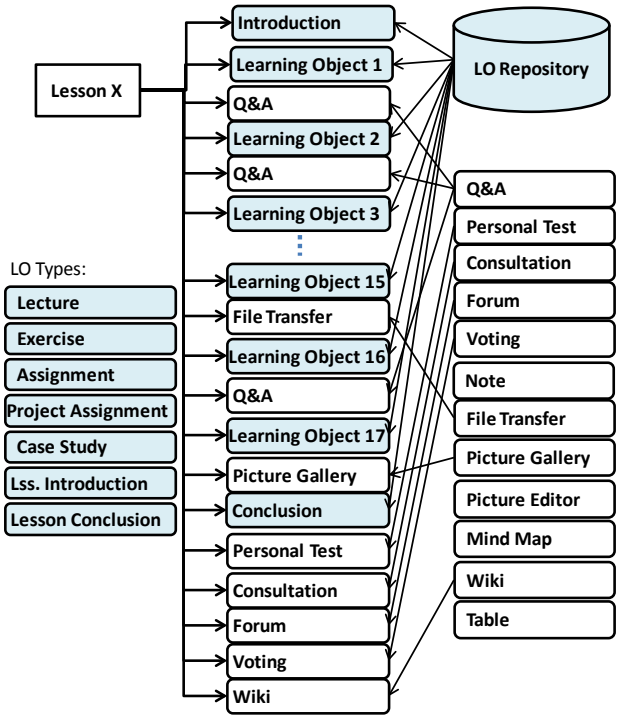

Figure 5: Configuration of an online lesson based on learning objects and interactive activities

By selecting learning objects from the LO Repository, lesson designer (professor) can choose LO created by him/her and any other LO. LO reusability reduces the cost of their development. Currently, selection of fine grain learning objects (usually 1-2 pages) is done manually by lesson designer. In future, it is expected that an intelligent software module (as an intelligent tutor) will do it, after identifying students learning styles and current knowledge levels.

There are several types of learning objects:

- Lecture
- Exercise
- Assignment (problem to be solved)
- Project Assignment (one semester work)
- Case Study
- Lesson Introduction
- Lesson Conclusion

LO Developer can develop these LOs by using QDITA authoring tool or MS Word templates prepared for each type of LO. The second option is for LOD Developer that are less familiar with QDITA Editor.

A lesson contains learning objects and different types of interaction and supporting activities (offered currently by LAMS, but new activities will be developed in future), as shown in Fig. 5. By selecting and adding available interaction and supporting activities students get very interactive and more appealing online lessons.

Developing and storing of learning objects is the first phase of development of e-learning content (Fig.6). Development of the LO Repository with thousands of LOs is the prerequisite and foundation for such personalized e-learning system.

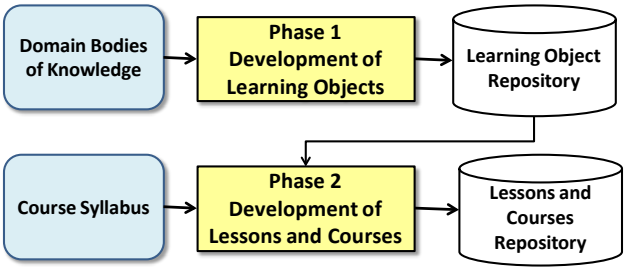

Figure 6: Two phases of development of e-learning content

5. COURSE DESIGN

During the Phase 2 of development of e-learning content, design and configuration of a course and its lessons need to be done. Online lessons are configured by selecting available and previously developed learning objects from LO Repository. Searching LO may be done using key words, names of learning objects or by using the navigational access to learning objects, described earlier.

Besides learning objects (including a Lesson Introduction LO), an online lesson may contain all interactive and supporting activities used also in Phase 1. Usually, during design and configuration of an online lesson, the following objects and activities are added:

- Test
- Project Assignment

- Case Study (in case when can not be included in a lesson)
- Consultation
- Forum
- Voting
- Wiki

Lessons and Course Developer design and configure all lessons and a course, according to its syllabus. Figure 7 shows an example of an online course. It has 15 lessons, tests and a project assignment.

Starting from the academic year 2013/14, all courses for the following bachelor programs have been prepared according to the described methodology:

1. BS Information Technology
2. BS Software Engineering
3. BS Business Information Systems
4. BS Operations Management
5. BS Management and Marketing
6. BS Graphic Design
7. BS Interactive Media Design
8. BS Fashion Design

Reengineering of existing learning contents required not only modification of the existing learning contents, but also development of new learning objects. It has been a huge work, but necessary for future development of more personalized e-learning contents.

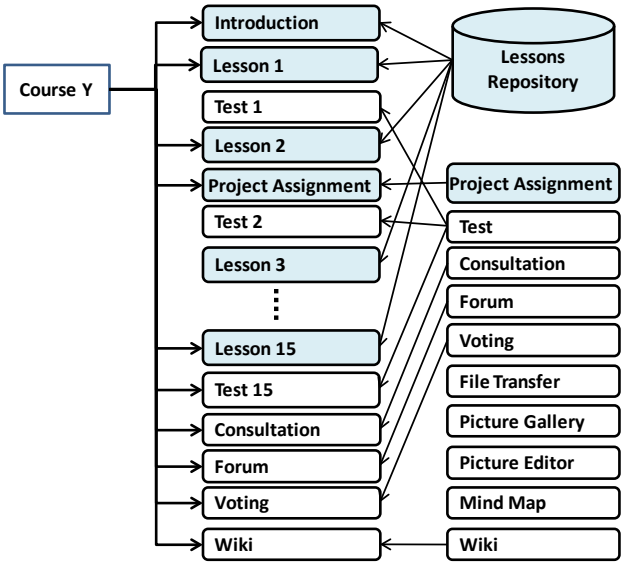

Figure 7: Configuration of an online course

6. CONCLUSION

In order to realize the following strategic goals:

- increase of student interactions and activities during e-learning sessions;
- implement more problem-oriented learning;
- support personalized e-learning; and
- increase the reusability of learning contents, when it is necessary, as it reduces costs of preparing learning contents, and can improve their quality.,

BMU has reengineered its bachelor and master programs:

1. new curricula and domain bodies of knowledge has been specified,
2. new e-learning methodology based on fine grain learning objects has been implemented,
3. new approach for design and development of online lessons and online course has been adopted.

This is the first but fundamental step towards development of personalized online lessons, planed for future R&D at BMU. Fine grain learning objects are prerequisite for personalization. The work presented, provides the foundation for further R&D work towards personalization of e-learning. At the same time, the work accomplished and presented, is to be used for all online courses of all bachelor programs at BMU starting from academic year 2013/14.

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