

DEVELOPMENT AND ENHANCEMENT OF LEARNING OBJECTS FOR ELEARNING SYSTEMS USING LIGHT AGILE METHOD

SVETLANA CVETANOVIĆ

Belgrade Metropolitan University, Faculty of Information Technology, svetlana.cvetanovic@metropolitan.ac.rs

MIROSLAVA RASPOPOVIĆ

Belgrade Metropolitan University, Faculty of Information Technology, miroslava.raspopovic@metropolitan.ac.rs

Abstract: *The international community is highly interested in developing repository of diverse learning objects that can be exchange and reused for different purposes. Development methods are often very time consuming and costly. There is a need to develop methods that will allow development and enhancements of learning object of high quality and allow flexible, agile and structured approach. The aim of this paper is to present light agile method for development and enhancement of learning objects. This approach is based on the synthesis of software engineering approach and pedagogical principles. This approach is outlined and illustrated on a case study for enhancements of learning objects developed for the Database course.*

Keywords: *reusable learning objects, agile methods*

1. INTRODUCTION

Importance of learning objects (LO) is the subject of many papers and studies related to the introduction and promotion of modern educational system which implements online and/or blended learning. Some researchers believe that the learning objects represent an effective way for the design, develop and deliver learning material that will allow a learner to discover and obtain the learning content that suits their needs. Learning objects present smaller units of learning material, which should be logically independent of other learning objects, even though they may be related to one another in the larger scope of a certain subject. As such, the idea of learning objects is to be flexible and reusable in the eLearning system. If properly developed and implemented, learning objects represent a good candidate to enhance the effectiveness of learning and learner's performance.

In his paper, Boyle argues that learning objects must be developed with potential reuse in mind [1]. In order to delineate principles underlying this LOs characteristic, he established an analogy between principles of software engineering, and pedagogical principles. Cook et.al. explained the approach for development of reusable LOs that is partly based on the software engineering principles of decoupling and cohesion [2], but is also influenced by notions of user-centered and participative design [3]. They consider that LOs should represent a result of discussions between teaching staff, learners and other team members such as the multimedia developer, manager and colleagues from partner institutions, etc.

Boyle et.al. provide a full life-cycle framework that guides LOs designing process, from setting learner's goals within institution and problem identification, all the way to the design and production of all parts of learning object [4]. This method is heavily influenced by 'agile' development methods that rejects heavyweight, bureaucratic approaches to software development such as the Waterfall method. Our research adapts this model, and presents it in the light of the specific examples given for the Database course.

This paper focuses on methods for development and improvement of learning objects. The focus of the paper is a method, which authors refer to as the "light agile" method that presents an iterative and creative process of development and design of reusable learning objects. In this agile and iterative process instructor, reviewer, multimedia developer and students are involved in a part or all stages of full-cycle of design, enhancements and reviews of the quality of the created content. In defining this method, it is considered that the entire process is based on the software engineering principles, which are implemented in LOs development.

The paper is organized as follows: In Section 2 the implementation of software engineering principles in learning objects development is highlighted. Section 3 describes "light agile" methodology for development of learning objects. Section 4 demonstrates the implementation of the described methodology on a case study for enhancements of learning objects developed for the Database course. Section 5 concludes the paper.

2. IMPLEMENTATION OF SOFTWARE ENGINEERING PRINCIPLES IN DEVELOPMENT OF LEARNING OBJECTS

In order to effectively and efficiently develop and redesign LOs content, the appropriate methodology for development of learning objects has to be defined and applied. Similarly as in the development of large software systems, one should determine the sequence of tasks that need to be accomplished, along with the methodology for LOs development. Choice of this methodology should allow the development team to achieve the best route to creating effective learning objects in the context of local opportunities and constraints. The key high-level functions that need to be covered by LOs development methodology are: analysis of learner needs, design, development, delivery and evaluation that are similar to the software development process [4].

When developing modular learning system, where LOs are designed in such way so that they can be reused and repurposed, one may consider implementing certain software engineering principles in their design and development, so that entire process is faster and more effective when compared to traditional writing of learning materials in form of the online textbook. Design and development of LOs can incorporate software engineering principles in two phases:

1. Development of initial learning content of LOs – cohesion and coupling
2. Design and enhancements of LOs content and visual presentation – light agile method

In the first phase when the initial content is developed for LO, this development can be based on the development of software modules, produced by applying the principle of modularization. During the process of modularization, software is broken down in smaller units (modules) in order for these units to be maintained more easily. The same principle of modularization can also be applied to the LOs content development, since LOs represent smaller logical units of the learning material. If these units are small and independent enough, their reusability and repurposing can be effectively conducted. Moreover, this approach will allow for redesign and enhancements for each LO to be faster.

In software engineering, each of the software modules produced by modularization has to meet certain characteristics, defined primarily by known principles of cohesion and coupling. As known, coupling is usually contrasted with cohesion. Low coupling is often a sign of a well-structured software system and a good design, and when combined with high cohesion, it supports the general goals of high maintainability. The principles of cohesion and coupling might be also applied in reusable LOs design and evaluation. To be highly cohesive, each

learning object should be based on one learning objective and/or clear learning goal. High cohesion of LOs allows increased understanding of their content. Such LOs may be easier to maintain and reuse. The principle of coupling is also crucial in the design of reusable LOs. The learning object should be “free standing” as much as possible. Tightly coupled LOs tend to exhibit the bad characteristics: a change in one LO usually forces changes in other one, and therefore, such LOs may be harder to reuse and/or evaluate [1].

It should be noted that process of LOs development, like in the software development process, starts with an analysis of the user's needs. In case of development of LO, user is a learner. The learner's needs must be put at the very centre of the design of learning objects. One of the difficulties is that a lot of times assumption has to be made in order for LOs match the cognitive capacities of a learner [4]. This issue is evident in many implementations of eLearning systems that were not successful, in which the reason for failure usually lays in the fact that user's perception and style of learning was not considered enough or at all when the learning material was written and designed for visual presentation.

The second phase of the design and enhancement of LO content is based on the “light agile” method, presented in this paper. This method is based on the modern approach to software development known as 'agile' or rapid application development (RAD) method. Agile process is an adaptive process that accepts the fact that software is difficult to control. The main aim of this method is to minimize the risk of incomplete or bad quality software by ensuring that software engineers focus on smaller units of work (they practice iterative development). This approach is resonant of approaches applied in the purposed “light agile” methodology for LOs development. Since the evaluation process can sometimes be based on the feedback received from the entire semester, and not always short 2-3 week sprints like in the software development, In agile methodology, design and development is an iterative process where the instructor, multimedia developer, reviewers and groups of students are involved in the full life-cycle development, design, enhancements and evaluation of [4].

3. LIGHT AGILE METHODOLOGY FOR DEVELOPMENT OF LEARNING OBJECTS

The goal is to provide a methodology that will allow a flexible approach when developing and enhancing learning objects. The idea is to provide high quality learning objects that are structured, adaptable, and ultimately reusable in different context. In order to reach certain level of reusability it is necessary for this development process to have a balance between structure

that is required for learning objects and flexibility, which will allow authors to be more creative, and implement different pedagogical methods, which are necessary for their courses. Group of learning objects is usually developed in order to meet the needs of certain learner, i.e. for a particular course. These learning objects are developed by course instructors and/or multimedia developers [4]. Course instructors are in charge of developing materials for learning objects along with conceptualizing the design along with proper pedagogical methods, while multimedia developers can serve dual purpose. One to provide their expertise in design and multimedia enhancements of the learning objects, and on the other hand they can prepare learning objects to be entered and published in a certain learning management system (LMS). Even though multimedia developers' main purpose is to enhance visual presentation of learning objects, it is necessary to have the instructor involved in the entire process, so that the emphasis is put on the quality and effectiveness of studying. On the other hand, involvement of course instructors and multimedia developers is an iterative process. More importantly, quality assurance and evaluation can be completed through involvement of the learner in the entire process, so that learning materials are tested with a certain group of students. This is referred to as "use before reuse" [4].

A. Use before reuse

Initially it is assumed that each instructor develops a plan for the course based on the learners needs. We will analyse the course that is prepared for the academic program. In other words, the learners needs in this case need to be aligned with the goals, objectives and outcomes of the academic program of a certain institution. In some instances it is necessary for the course instructor to propose course outline and ideas what pedagogical methods will be used to design learning objects in order to see if this is in line with institutional aims.

Each group of learning objects should be evaluated, not only with academic staff, but primarily with students who will use these materials to study. This evaluation period can take from one week to the entire semester. The feedback about the conducted evaluation from students should be carefully recorded and analyzed. This type of assessment should point out not only the quality of presented material and visual effectiveness, but also whether the proper pedagogical methods were used for their presentation. Evaluation can incorporate several methods:

- Qualitative methods such as surveys, direct observation, and live interviews
- Quantitative methods such as assignment and test scores, performance analysis at the end of the course, frequency of usage of learning materials, etc.

This feedback and analysis should give a better input about things that should be changed, adapted and enhanced, throughout the semester. By the end of this phase learning objects are ready to be published and stored in the repository.

B. Enhancements of LO using light agile method

The two main stages in developing the learning objects are developing learning content and developing multimedia content for the learning objects. Once the instructor develops learning content for the learning object, this learning object is forwarded to multimedia developer. It should be noted that there should be an intermediate step involved. Before forwarding the content to the multimedia developer, learning content should be first forwarded to the reviewer, who should give constructive suggestions about improvements of the content as the reviewer should be expert in that particular area for which the learning object is written. However, this step is not necessary since it may increase the cost of the entire process, but this step is recommended before learning object is forwarded to multimedia development, in order to ensure academic quality of the learning object. Once the multimedia developer receives the content for learning object, multimedia is built based on the given specifications. The resulting learning object is given back to the instructor for a review, so that instructor will ensure that learning object has not lost its essence. This iterative process between instructor, reviewer and multimedia developer continues until all specifications and criteria are met. However, multimedia developers cannot serve as independent entities in the process, as they have to work along with specifications and content provided by the instructor, and possibly reviewer. Multimedia developer should develop visual presentation only based on the instructor's specifications, who can provide their ideas as a prototype that needs to be refined. This iterative process allows instructor to be actively involved in development of multimedia. In addition, once the instructor receives a feedback from students, not only that the learning content can be changed, but the entire design of the learning objects, including its multimedia and visual presentation.

Since learning objects present small content, it is typically that one development group, both instructor and multimedia developers are working on several learning projects in parallel. This light agile model is given in Figure 1. This process is more agile and allows for rapid development and redesign of the learning objects. Enhancements and redesign can be done based on the reviewer comments and members of the team, but most importantly learners feedback should be used for continual and further improvements.

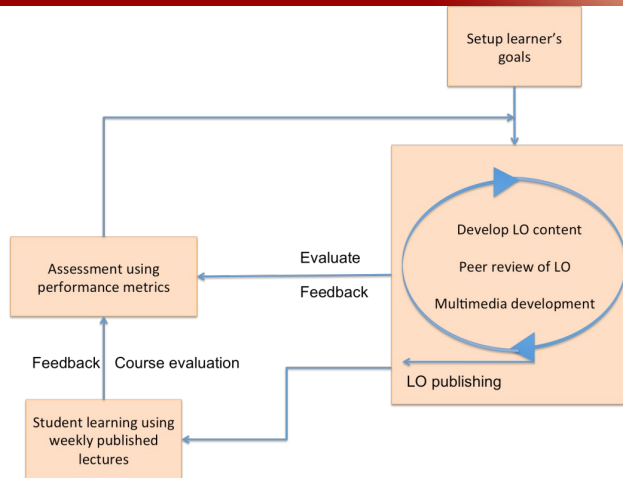


Figure 1. Iterative process of development and enhancement of learning objects

4. ENHANCEMENTS OF LEARNING OBJECTS FOR DATABASE COURSE

In this section, the application of the previously described principles and methods are illustrated by describing design and development of learning objects developed for a Database course. Key concepts of developing structure and logic of reusable and searchable learning objects for the Database course were presented in the previous work [5]. According to this model, learning objects are organized in hierarchical tree representation, all structured around learner's needs for the academic program and tailored towards the course syllabus. Hierarchical organization represents different concepts of the course and is based on the coupling of concepts. Each concept covers several topics. In order to achieve reusability of learning materials, each topic is further divided into smaller learning objects [5].

During the writing and designing of initial content of specified learning objects, the authors realized that the above principles of cohesion and coupling are not fully applied and that learning objects should be enhanced. For example, ontology of the concept "Information Management Concepts and Fundamentals" contain learning object called "Database management system", authors' intention was to describe different types of database system: relational, object and object-relation. In initial material, these 3 topics were included in the same learning object. However, the principle of cohesion indicates that there should be a separate learning object for each Database management system type. An immediate advantage is that the teacher can select the order in which these learning objects are combined; for example, a teacher dealing with experienced student may wish to deal with these in sequence; while another teacher with a different group of students may choose to combine these learning objects with another learning

object that deals with other features of the database. Based on this example, one can conclude that applying the principle of cohesion in LOs content designing, primarily increases LOs reusability by providing more flexibility in achieving different learner's goals and instructor's aims.

Initial design of the learning objects content by applying the principle of coupling can be shown on the example of the concept "Database Query Language" where SQL statements and their use should be explained on a large number of examples. Each SQL statements (for example statement INSERT, DELETE, UPDATE, SELECT etc.), together with many examples that illustrate their usage, is explained in separate learning objects. It is important to note that in all learning objects for the SQL statement, the same tables were used to illustrate how the statements were used on certain tables in a relational database (i.e. tables EMPLOYEE and COMPANY). This example includes explanation of the use of SQL commands, and the two tables (their attributes, primary and foreign keys). In other words, despite the fact that we must describe the same tables, the description cannot be put in only one learning object, but must be repeated in each of them. Only in this case, learning object that explains one type of SQL statement should not refer specifically to content in objects than describes other type of SQL statement. In such a way, learning objects become decoupled and they can be easily reused and evaluated.

After development of the initial learning content for LOs, the phase of content enhancements and visual presentation is performed using light agile method. In the case of Data base course, at the beginning of this phase, course instructor estimates if the written LOs are in line with the course and with the previously defined learners' goals for the particular academic program. If the LOs are not in line with the aim and goals of the academic program and goals, previously written LOs need to be revised and enhanced. This can be done as a point of view how these LOs fit into a concept of a lecture within this course. Ideally, these LOs are written from the beginning to be good enough as stand alone units, but that may not always be the case. When reviewing LOs for the lesson concepts, additional content should be designed, such as multimedia and different pedagogical methods such as interactive and supporting activities that allow students to interact with the professors and assistants, with other students, assess their understanding of the learning content and express their opinions and their ideas.

During one sprint in the agile method, learning objects were further designed and enhanced. One sprint assumed development and enhancement of all LOs needed for one week's material. The sprint involved a team consisting of course instructor, multimedia developer and students. Due to the high cost, at this stage of LOs enhancements, the reviewer was not included. At the beginning of a sprint,

course instructor would forward the group of LOs content to multimedia developer who would build a multimedia presentation based on the instructor's specifications. Multimedia is built during an iterative process between instructor and multimedia developers until both parties are satisfied with visual presentation. At the end of a sprint, the group of LOs is published, unless course instructor and multimedia developers assess based on the performance metrics, that the entire design of the learning objects must be redesigned.

After publishing of learning materials, students are provided with access to view it and study from them. In the case of the Data base course, the feedback from students was obtained based on interactive activities that allow them to assess their understanding of the learning content and express their opinions and ideas about what they learned. At the end of the semester, course instructor carefully analyses students' feedback and based on the results decisions are made whether certain LOs need to be further improved.. Thus, the period of full evaluation takes the entire semester. At this point, it is also possible to include reviewer, if the reviewer was not used during the sprints.

5. CONCLUSION

This paper focuses on methods for design and development of reusable learning objects that are based on the software engineering principles. The principles of software engineering can be incorporate in two phases of LOs development: during the initial learning content definition, and later, when LOs content and their visual presentation need enhancement. When course instructor has to develop the initial LOs content for one course, he must break down course material into smaller units. To be reusable, LO has to meet characteristics defined by known software engineering principles of cohesion and coupling. Later, when LOs content should be enhanced, a "light agile" method, also based on the modern approach

from software engineering can be applied for a faster and more effective development of LOs. The "light agile" method was illustrated in this paper on a case study for enhancements of learning objects that were developed for the Database course.

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