DESINING REUSABLE ACTIVE LEARNING OBJECT BY USING ITS INFORMATION MODEL

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Introduction

In the case of a well-developed communication infrastructure the information conveyance alone (teaching material, placement of tasks) is an ineffective method of increasing the quality of learning. Modern ICT-based applications of learning and studies are focused on active learning that improves the quality of e-learning. Active learning is applied in virtual learning environments by using various learning objects (LOs) that include knowledge assessment tests, instructional modelling, practical tasks, experimental tasks, interactive presentations, discussions, etc. LOs that implement these methods of active learning are called active learning objects (ALOs), during the learning process they stimulate a learner to take some action or input sensible data.

A number of active learning objects may be developed for one topic of studies; they may differ in difficulty, goal, interactivity, activity rate and the scope of knowledge and concepts required for making the right decision. Therefore the authors of learning tasks that use various activities need means for methodical design of reusable active learning objects that take into account the above mentioned criteria. First of all, in order to ensure reusability, a LO must be designed with this purpose in mind from the very beginning of the development life-cycle, i.e. reusability should be intended in the ALO specification [13]. ALO information model (IM) that enables us to design the semantic structure of ALO and obtain specification of its learning components may be applied. In this paper we present how to develop a reusable ALO that would enable implementing activity based learning tasks with different goals.

Active learning objects and their characteristics

According to the standards of LO metadata description [11] the interactivity level can be used to classify LOs into three different types: active LO, passive LO and mixed LO. The role of the active LOs includes not only rendering the learning content, but also describing the thinking processes that are possible in some given context. On the contrary, the passive learning objects that are mostly used in the virtual learning environments just present the learning material to the learner and remain passive when the material is used. D. Jonassen and D. Churchill selected several criteria that describe LOs, these criteria are used in the table below to compare the specific features of passive and active learning object design, creation and application.

Table 1. ***Characteristics of learning objects by criteria***

Criterion	Passive LO	Active LO
Character of information	Factual information is presented in textual and/or visual format.	The content focuses on stimulating the learner for making a decision in a given situation based on visual or textual information.
Character of learning activities	Learning activities are based on reading, listening and observing.	Learning activities are based on instructional modeling and experimentation. Passive learning methods are applicable beforehand.
Character of correlation with LO	The correlation is based on the choice of references and control of presentation of visual material.	In ALO the following interactions are implemented: data entry, values and parameter selection, meaningful manipulation of objects, selection of links.
States of knowledge (according to Bloom's taxonomy)	During the use of the passive LO the learner passes through the states of knowledge and perception.	During the use of ALO the learner passes through the states of knowledge, perception, cognition, application, analysis and synthesis.
Correlations of the learning content	In the passive LO interdependence correlations of the LO learning material are relevant to extending and deepening the topic under consideration.	When using ALO, the correlations of the learning content are based on the dependencies of the learning material implemented in the ALOs and on the interrelations of ALOs and their learning components according to their difficulty or user's behavior.

According to the given comparison, the ALO differs from the passive learning object in the methods and technologies that are used to design and convey the learning content. Passive LO is based on structuring the learning content using small and mutually independent learning entities.

Active learning object reuse features

The issue of LO reuse is important in three aspects: format, interpretation and compliance from didactic point of view [16]. The first issue is addressed by the various e-learning standards, but the other two, when used for ALO, require new solutions and concepts [16]. As noted by T. Blažauskas [2], "LO is created not only to be used once, but also to be used by adapting it to the individual requirements of each learner". As described in [15], ALO reuse is achieved when the processes of LO creation and usage are separated. I. T. Hawryszkiewycz [7] also observes that reuse is feasible by using the whole ALO, as recommended by the majority of standards, or by employing the reuse of ALO learning activities. According to V. Dagienė and E. Kurilovas [6], LO reuse possibilities are such: using it as is, recomposing it, adapting it to the particular application context, using it as an example, remodeling it after the changes of learning subject or environment.

According to K. Palmer and P. Richardson [14], ALO reuse may be divided into these three types:

1. Re-use, which is used upon the failure to make any changes in the learning object.
2. Re-tasking, when we use it without changing the ALO, yet it is transferred to another context of education with another goal.
3. Re-purpose, when ALO is altered in order to reach the intended goal that differs from what was defined by the author of the ALO.

When the semantic structure of the ALO is known, the aforementioned reuse types can be employed to pursue two goals: the creation of multifold and individual ALOs that are adapted to the particular learning objectives and the creation of ALOs by adapting them to the educational situation [9].

Information model proposed to other authors

On the world scale, LO information models have been developed and used for several years already. Models of LOs developed by the companies IMS Learning Design, SCORM and Learnitivy are used most widely. The major aspects analyzed thereof include models of including learning components into the LO and their aggregation into a lecture or a course. Scholars developing ALO information models in the world (D. Merrill, F. Lin, A. Bouzeghoub et. al.) seek to link the learning components comprising ALOs with semantic links thus providing applicable scenarios of e-learning.

In this paper we will examine three ALO information models:

- ALO IM proposed by D. Merrill [12] is based on the use of knowledge objects for the context of learning activity. A knowledge object is defined by expressing its knowledge structure together with learning context. This researcher asserts the knowledge object is a plan of knowledge representation that consists of knowledge components and this is the precise way to specify the content and knowledge of the subject of a lecture.
- ALO IM proposed by F. Lin [10] is based on the choice of goals for the formation of learning sequence. F. Lin suggests ALO should be treated as a set of learning tasks that are used to achieve the given goal. The learning tasks are connected by causal relationships that enable application of inconsequent selection of ALO tasks that is fitted to individual needs of the learner.
- A. Bouzeghoub et. al. [3] proposed ALO IM with additional semantic description. The author proposes to reuse the ALO by composing it from other instructional component and semantic operators (sequence, alternative, parallel). Thus each time we get a different ALO model that is tuned to the learner's requirements.

Table 2. ***Comparison of ALO information models***

	D. Merrill ALO IM	**F. Lin ALO IM**	**A. Bouzeghoub et. al. ALO IM**
Name of the reusable part of LO	Knowledge object	Task	Instructional component
Are there semantic links between the constituent parts of the LO?	Yes	Yes	Yes
Method of reusability	The LO is moved to another context of the learning activity	Internal composition of the LO is changed according to the selected learning goals	Internal composition of the aggregated LO is changed according to the selected goals

The comparison shows that D. Merrill analyses the structure of knowledge and demonstrates the relations among the above mentioned knowledge object components and among other knowledge objects. Nevertheless, learning activity context is used to form it: presentation, investigation, practice and imitation. ALO IM proposed by F. Lin and A. Bouzeghoub et. al. uses the cause-effect relations among the small learning units (task, instructional component), but does not define the semantic structure of the reusable part, what affects the flexibility of ALO usage and its reusability for seeking different goals.

ALO information model formation

The proposed ALO information model takes into account two features of the information models that were presented in the previous chapter. First, ALO is composed from the separate entities that are called learning components and this way it satisfies the requirements for reuse. Second, an ALO component is made of data elements and uses their mutual semantic and causal relations to describe the semantic structure of ALO. The content of the learning subject that is implemented using the ALO is expressed by employing the method of contextual modeling proposed by V. Vieira et. al. [19]. It differs from other methods in the way that the highest level is entered, the concepts of the context independent from the particular sphere are entered whereof; it features flexible data and information supplement and enables one to reach the dynamism of contextual elements under the change of circumstances by using a focus for this purpose. First of all, following its three levels (see Fig. 1), task focuses are separated that enable us to specifically limit the expression of the learning topic context by distinguishing the essential objects of the analyzed subject field and relevant features and their values.

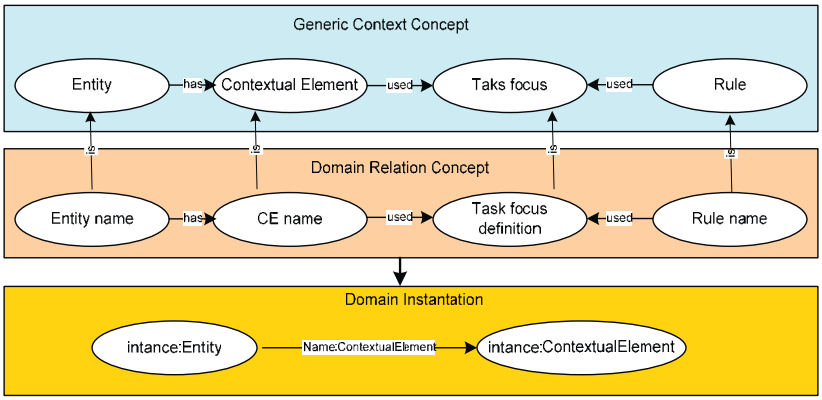

Figure 1. Levels of contextual model

They are characterized by their entity, contextual elements and the values they acquire. This triplet together with boolean value comprises the contextual information that describes the problem used in the learning task. The rules allow designing how the learner's activity is stimulated by employing contextual information, i.e. by analyzing the given situation of the task the learner has to make decision on, i.e. to identify the contextual information and to take necessary actions after having evaluated it. A detailed description of the stages of ALO information model formation which are used in the algorithm is given in Figure 2.

The suggested algorithm for creation of ALO IM allows to design the semantic structure of ALO gradually and to form causal relationships among the information objects (IOs) that comprise it, while information objects are described by the contextual information. A generalized created ALO information model is given in the diagram below.

The following characteristics are typical of the created ALO information model:

1. The structure of the ALO IM is comprised of information objects, and information objects are comprised of data elements that, when rules are applied, describe the semantic structure of the analyzed topic.
2. Semantic relations are applied among the data elements of the information model, whereas the interdependence of the information objects is expressed by the contextual information.
3. The following concepts of contextual modelling are used to express the semantic structure of the ALO in the information model: entity, contextual element, focus, and rule.
4. An expert in the subject creates an ALO information model and receives the specifications of information objects that comprise the information model, according to which an active learning object as well as learning components comprising it are developed.
5. The learning component implemented by the information object seeks one goal, whereas altogether they (i.e. the active learning objects) seek the common final goal.

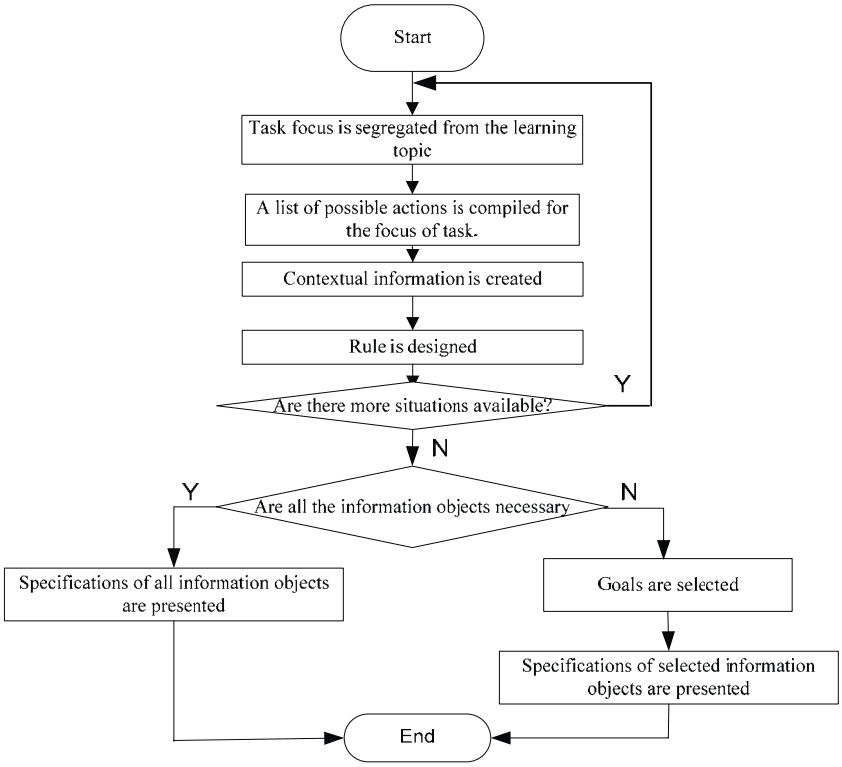

Figure 2. ALO information model formation algorithm

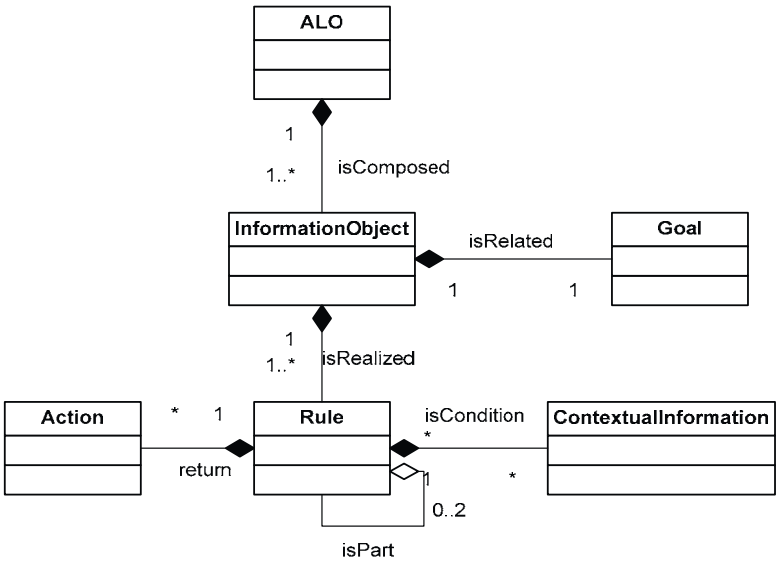

Figure 3. A generalised ALO information model

Creation and application of active learning object reusability

The most significant benefit of the proposed ALO IM is based on the multiple reuse of the ALOs that are created from it and used to achieve different learning goals. This feature is important as the same ALO can be used in various learning contexts: learner groups with different abilities, courses with different requirements for learning achievements.

This paper presents the usability and reusability of the ALOs that are employed in the course of data structures. Every year this module of studies is taken by a number of students (around 200 from Kaunas University of Technology and Šiauliai University) that come from various fields (informatics engineering, informatics, information technologies, computerized learning, computational linguistics). The expert of course of data structures uses the algorithm of ALO information model creation and provides application of the ALO specification. ALO from the subject of "Algorithms for inserting/deleting elements in B-tree" is implemented by TestTool

graphical simulation environment, therefore the application of ALO specification is presented by providing the details about how it can be used in the authoring tool of this environment. The application that implements the proposed algorithm of ALO IM creation provides the field expert with full specification of the information objects that comprise ALO. The specification is given in XML and supplies the contextual information that describes the learning situations, and components of the actions that are triggered by it.

The obtained ALO IM and specifications of ten information objects that comprise it are imported to the authoring tool of graphical simulation environment TestTool (See Fig. 4) and ten learning components are generated respectively. These components make full implementation of ALO. Specification of each ALO component is provided in "Specification" tab and is used by the author to create learning situations. Specification of the ALO component in the example below describes two learning situations that must be implemented by the author: the element that is deleted from B-tree must be in the page; the leaf from which the element is taken must have the sufficient number of elements.

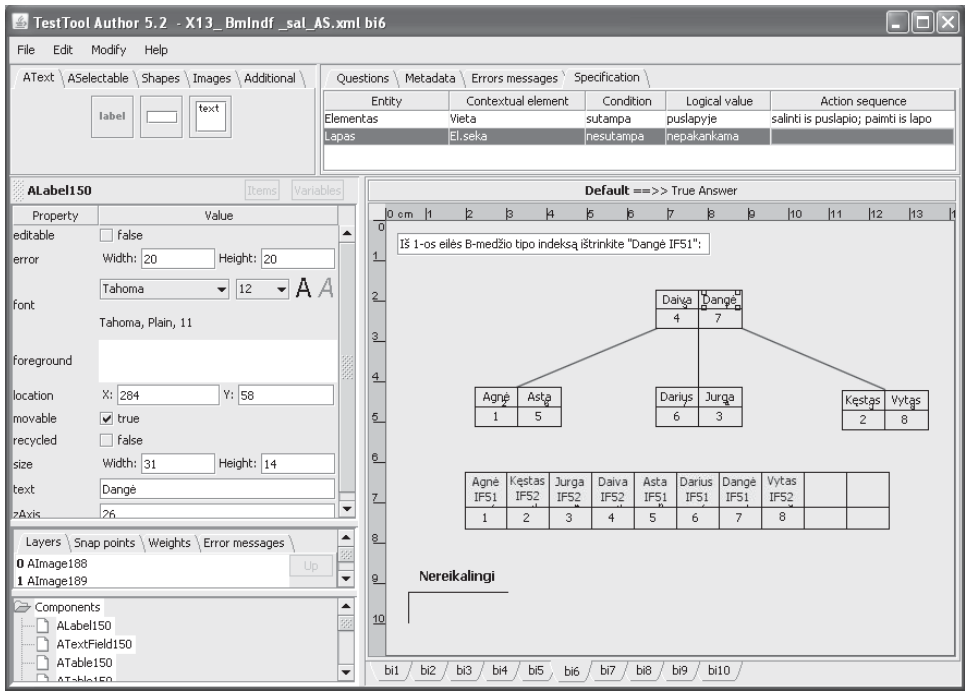

Figure 4. LO realization from learning components specifications in TestTool author program

According to G. Teege, reusability sets out requirements of abstractness and applicability [18], i.e. it should be possible to reuse the created ALO by adapting it to the demands and abilities of the user. ALO that was implemented using ALO information model can be considered reusable in these aspects (Fig. 5):

- the author reuses ALO by changing its content according to the learning components. This means the author can provide the full ALO that is made of all learning components or he can decide to provide an incomplete ALO, i.e. only a portion of learning components that are selected after setting the goals that are required to reach designated learning achievements.
- when full ALO is presented during learning process, a student can control the study course himself. Such possibility is provided by the fact that author describes the ALO components with metadata as they are created from information model. When metadata is available, the learner can use them to control the learning process by choosing the relevant learning components.

As we can see from the ALO reuse activity diagram, the active learning object that is created from ALO IM fully conforms to the following reuse cases:

- Re-use of full ALO that was created by the expert by "inserting and deleting elements in B-tree";
- Re-purpose of ALO, i.e. the author can compose it in the different manner to meet different learning goals thus adapting it to different context. This way the same ALO is reusable for different requirements for learning achievements in various curricula.

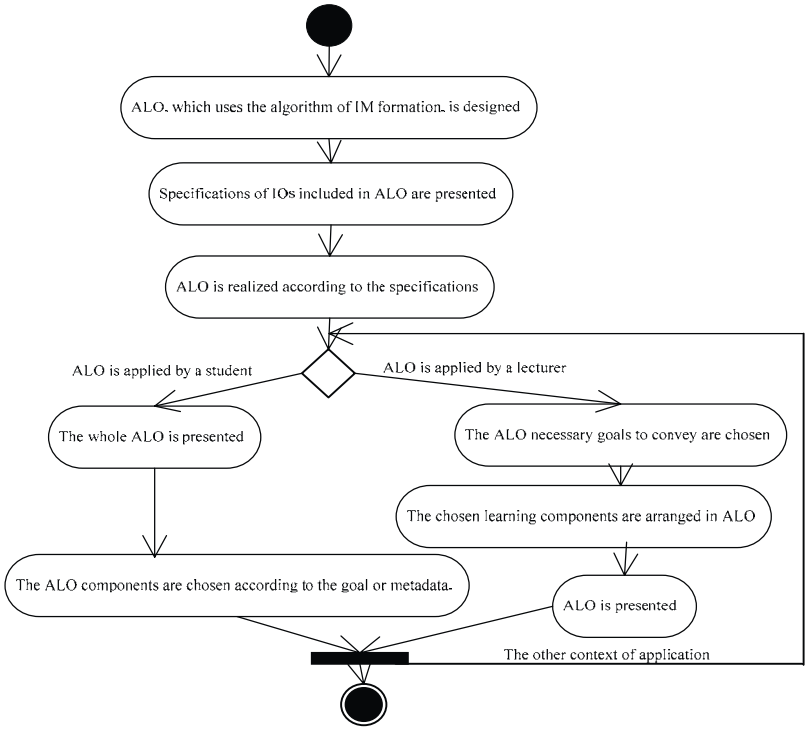

Figure 5. ALO reuse activity diagram

Conclusions

1. To express the context of the development of the ALO. The analysis of context of the development, creation and application of LO has shown that by applying the contextual information of the object under consideration we may design possible cases of the vigorous activity that are used to present the learning material.
2. To design the semantic structure of reusable information objects of the smallest aggregation. For its formation we used the concepts of the chosen contextual modelling method and their interdependence, we have adapted the algorithm of identification of the contextual information, developed the algorithm of rule formation, which enables us to design ALO situations and relations among them.
3. To form the specification templates of the ALO components in XML format which, when used by an author in editors for developing ALOs of different systems, would enable him to implement the ALO components.

According to the results of the experimental application it may be stated that active learning object created on the basis of ALO IM enables us to create an ALO of known semantic structure and to reuse it in order to seek other goals.

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Summary

Orientation of applications of studies and learning based on modern information and communication technologies (ICT) towards active learning improved the quality of e-learning. Whereas the design, creation and application of active learning object (ALO) that realizes the methods of active learning are the main tasks that are approached by researchers with a view to improve its reusability by adapting it to learners' various needs and different abilities. For the solution of this problem, the information model of active learning object is introduced in the article. This model enables to design ALO and generate the specifications of learning components it consists of that help to implement reusable ALO.

Keywords: active learning object, information model, reusability.

DAUGKARTINIO NAUDOJIMO AKTYVAUS MOKYMOSI OBJEKTO PROJEKTAVIMAS TAIKANT JO INFORMACINĮ MODELĮ

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Santrauka

Šiuolaikinėmis informacijos ir komunikacijos technologijomis grįsto mokymosi bei studijų orientavimas į aktyvų mokymąsi pagerino e-mokymosi kokybę. Aktyvaus mokymosi objekto įgyvendinamo aktyvaus mokymosi metodais, projektavimas, kūrimas ir taikymas – tai pagrindiniai uždaviniai, kurie mokslininkų sprendžiami gerinant jo daugkartinį panaudojimą, pritaikant prie įvairių besimokančiųjų poreikių ir gebėjimų. Šiai problemai spręsti straipsnyje pristatomas aktyvaus mokymosi objekto informacinis modelis, leidžiantis projektuoti aktyvaus mokymosi objektą ir generuoti jį sudarančių mokymosi komponentų specifikacijas, pagal kurias realizuojamas daugkartinio naudojimo aktyvaus mokymosi objektas.

Prasminiai žodžiai: aktyvaus mokymosi objektas, pakartotinis naudojimas, informacinis modelis.

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