A Framework for Learning Objects Reusability within Learning Activities

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Abstract

Over the last decade Learning Objects (LOs) have gained a lot of attention as the basis for creating and handling educational digital content in technology-enhanced learning. The main advantage of LOs is considered to be their potential for component-based reusability in different learning settings. However, despite the importance of the concept of reusability and its potential benefits in educational content production and deployment, there is not a consistent framework for LOs reusability that would allow organizations to assess the conditions and eventually implement systematic LOs reuse. This is a drawback in adopting the LOs paradigm towards reducing costs and effort, while maintaining high quality. In this paper, we study the process of reusing LOs within the context of a technology-enhanced learning activities design and development, we discuss existing efforts to define explicit LOs reusability processes and identify their limitations, and, finally, we propose a consistent framework for LOs reusability which has been already used in various European Initiatives in the field. We consider this work, as an essential step for developing metrics that can be used in measuring the cost effectiveness of LOs reuse in technology-enhanced learning.

2. What is Learning Objects Reusability?

The main arguments in favor of LOs reuse are twofold. On one hand, LO reusability is highlighted due to the anticipation of cost reductions in the design and development of educational resources while maintaining quality. This is based on the assumption that the more times a LO is reused, in different learning settings, the more cost effective that is. On the other hand, LO reusability can be an indicator for a high quality education resource. This is under the assumption that the more a LO is reused the more likely is to be of high quality as more teachers and/or learners will have the opportunity to interact with it and provide feedback on its use and quality. However, despite the importance of the concept of reusability the research community has not agreed to a commonly accepted definition of the term “reusability” resulting to multiple interpretations. The concept of LOs reusability, just as the concept of LOs, is presented in LOs literature in different ways as seen in Table 1.

Hence, based on the above definitions, we can conclude that the ability to reuse LOs includes the ability to reuse them in a different learning context and/or for a different targeted group and/or for the attainment of a different learning objective and/or for a different subject matter (for example physics and geography, math and arts). At this stage, it is important to note that the dimensions that affect the potential for
LOs reusability are similar with the characteristics that define a learning activity [5, 6]. According to [5] a learning activity is a specific interaction of learner(s) with other(s) and with an environment (optionally involving resources, tools and services) that is carried out in response to a task orientated towards specific learning outcomes. Furthermore according to [6] there are three dimensions that constitute a learning activity: the context within which the activity occurs, the pedagogical approach adopted (i.e. problem based learning, inquiry based learning) and the tasks undertaken to achieve the intended learning outcomes.

Table 1. LOs Reusability Definitions.

| LOs can be used over and over again in similar contexts or in domains other than those for which they were designed. [1] |
| A LO is predisposed to be reused in multiple instructional contexts. [2] |
| Reusability is the extent to which a LO can operate effectively for a variety of users in a variety of learning contexts over time in order to achieve the same or a different objective from that envisaged by its supplier. [7] |
| Reuse of LOs is any kind of use of existing LOs which are already used in a certain context for teaching or learning by trainers or learners in a new context to serve the same or a new purpose. [8] |
| To reuse the LO with a different group of learners for which the LO was originally created. [9] |

Based on the above discussion, in this paper we adopt the following definition for the concept of LO reusability: “Learning object reusability can be defined as the extent to which a Learning Object can be used in different digital or non digital learning activities, where a learning activity is defined as the interaction of learner(s) with other(s) and with a learning environment, which emerges as a result of performing a task within a particular learning context in order to achieve one or more learning objectives”.

3. The Process of Reusing Learning Objects

In literature there are some works that attempt to define the steps implemented in the LOs reusability process in practice [8, 9, 10, 11]. Collis & Strijker [10] argue that a LO can pass through six (6) different stages during its lifecycle: Obtaining: the first stage of the lifecycle is obtaining or creating a LO, Labeling: the LO created in the previous step is described with metadata., Offering: the LO is offered in a Learning Object Repository (LOR) so that other people can find it and retrieve it, Selecting: a user searches and selects from a LOR the LO that will suit the new needs, Using: after a LO is selected, it can be used either as is in a new learning activity or adapted in order to match the needs of the new learning activity, Retaining: after the use of the LO there are three possible choices: the future use of the LO, its revision or its deletion from the LOR.

There are two main drawbacks in this proposal. First, in order for individual users to make use of existing LOs, they must be able to efficiently search for LOs and then evaluate the LOs returned as a result of that search, as whether or not they are appropriate to be reused for meeting their specific expectations [12]. For that reason, in our work we propose that the step of selection should be broken down into two discrete steps: searching for appropriate LOs and selection of the most appropriate ones. Second, this proposal of does not take into consideration the possibility of disaggregating a LO into its constituent parts and the selection of those suitable parts for the new learning activity [9, 13]. Therefore, if a LO is not reused in a learning activity as it is, then, two more steps may be required, that is the adaptation and/or the aggregation with other LOs.

Another attempt to define the steps implemented in the reusability process was made in [9] where the step of “Using” in [10] is further analyzed. Considering both re-use, which means that the LO can be reused as is in a different learning activity and re-purposing, which is the transformation of the LO in a way that suits the new learning activity which differs from the activity it was created for, this proposal identifies the steps of: Modularization (that is, splitting the LO into several smaller LOs and selecting the appropriate ones), Adaptation (that is modifying LO with regard to one aspect, i.e. language or duration, to make it fit to the new learning activity), and Aggregation with other LOs to create a new one. However, this proposal does not take into consideration issues that have important consequences in time and cost of development, such as the selection of the appropriate LOs, the description of the LOs derived from the reusability process with metadata and the integration of the LO into the new learning activity [11].

The most complete effort for the explicit definition of the steps involved in the reusability process was made by [11]. The authors describe the reusability process from a quality point of view and in relation to the other two proposals, they add steps in the process such as: Approve, where a LO before published in a LOR is reviewed (i.e. peer review) in order to ensure its high quality, Evaluate that includes the criteria based on which the selection of suitable LOs for reuse is made, Integrate that includes the technical (i.e. integration in a LMS) and/or pedagogical integration (i.e. order of appearance of LOs) of the LO into the new learning activity. Also, the authors present the step of Repurpose & Reuse where the transformation of the LO takes place so that it can be reused in a new
learning activity. They argue that in this step the following actions may occur: disaggregation of the LO into its constituent parts, aggregation of the LO with other LOs, modification of the LO content and modification of the sequence of the constituent parts of the LO. However, in literature we can find more adaptation types than modification of content and/or sequence such as the adaptation of its presentation [4]. Thus, it is important to define explicitly what adaptation of a LO means.

Furthermore none of the above approaches include in the reusability process the identification of needs that will lead to the selection of an appropriate LO or if an appropriate LO does not exist to the creation of a new one. Identification of needs and intended learning outcomes are the first factors that influence the LO creation process [7]. Finally, another important step not mentioned in the above approaches that encourages the LO reuse in different learning activities, is that of feedback. Feedback is needed to support LO selection and quality control. It is important that users of a LOR provide feedback for the use of a certain LO, providing advices/comments to other users and assess its quality [13, 14]. The step of feedback could be integrated into the step of LO’s metadata characterization. However, it may include components such as rating that cannot be integrated in any of the IEEE LOM elements, so it has to comprise an individual step.

4. A Framework for Learning Objects Reusability

Based on the study of existing proposals (sections 3), as well as the international experience from the use of LOs in practice, we describe a Framework for LOs Reusability. Figure 1 presents the steps included in the proposed reusability framework:

![Figure 1. Learning Objects Reusability Framework](image)

**Identify Needs:** The first step of the proposed reusability framework is the identification of needs. In this step the role: instructional designers define the requirements that a LO must fulfill in order to be successfully used to support the learning activity they wish to implement. Therefore, the result of this step must be the explicit definition of the dimensions of the learning activity in which the LO will be used.

**Search:** Before a LO is created from scratch an interested user searches the LOR to examine if there is one or more existing LOs that fulfill the requirements of the new learning activity (defined in the previous step) and therefore can be reused. Searching in a repository usually involves the search based on criteria (fill in text fields or select a value from a vocabulary) that corresponds to certain metadata elements and the return of one or more results that fulfill the search
criteria. The result of this step is not a LO, but one or more metadata records that correspond to the search criteria. If the search results do not return a LO that fulfill the requirements defined in the previous step, then the role:authors can go to the step of developing a new LO (Develop). Otherwise, the interested entities go to the step of selection (Select).

**Develop:** At this step the authors develop a new LO to support the learning activity with the characteristics defined during the identification of needs.

**Describe:** At this step the LO developed in the previous step is described with metadata following either IEEE LOM or an application profile created to serve specific needs. The entities responsible for the characterization of LOs with metadata may be either the metadata specialists, or LO authors or both.

**Offer:** The LO that has been already described with metadata in the previous step is offered to the LOR, so that other people can use it. Sometimes this step is done simultaneously with the previous step.

**Approve:** Before a LO is published to the LOR and made available to its users, it may be reviewed (i.e. peer review) in order to ensure its quality.

**Publish:** Since a LO has been described with metadata and considered to be suitable for use, it can be made available (with or without usage restrictions or cost) to other users of the repository. This can be done either by publishing only the metadata description of the LO to the LOR or by publishing both the metadata description and the LO itself to the LOR.

**Select:** The interested entities in this step must evaluate the LOs returned as a result of the step of Search in order to select the one that satisfies to a certain extent the requirements of their learning activity. The fundamental criterion that should affect the decision of LO selection must be the requirements defined in the step of needs’ identification. If a LO fulfills those requirements, then it can be reused as is. Otherwise the LO must be modified in order to meet the specific requirements of the learning activity in hand. Other criteria that influence the decision of LO selection are comments made by other users, evaluations (i.e. peer review) of the LO or number of users downloaded the LO. A LO selection may also be based on copyright restrictions or cost.

**Obtain:** Since the appropriate LO has been selected, the interested entities can obtain it. This sometimes requires usage permission by the author of the LO or payment. There are two ways for obtaining a LO: (a) to download the LO locally, (b) to access the LO through its URL. If at the step of selection has been found that the LO fulfills the requirements of the new learning activity, then the interested entities can reuse the LO directly after integrating it into their learning activity. Otherwise they must go the next step (Modify).

**Modify:** Often, direct reuse of a LO is not feasible because it does not match the requirements of the learning activity. For example, the learning activity in hand may differ in any of the dimensions in relation to the initial learning activity, namely the learning context characteristics (Subject Matter, Difficulty, Pedagogical Approach, Learning Objective, Characteristics of the Participants, Environment Type, Duration) and/or the task characteristics (Type and Technique, Role, Interaction Type, Tools, Services, Resources and LOs, Assessment). As a result the following sub-steps may occur: **Disaggregate:** In this sub-step a LO is decomposed into its constituent parts and those parts that match the requirements of the new learning activity are identifies. The disaggregated LO constitutes a new LO. For example an image with its title and description can be disaggregated as a new LO. However, this LO may not be suitable as it is to cover completely the requirements of the new learning activity, i.e. the title and description must be translated to another language. Therefore instructional designers or authors have to go to the step of adaptation. **Adapt:** In this sub-step the LO modified to fit to the requirements of the new learning activity. An example of adaptation is the translation of LO’s content from English to Greek language. Moreover, it is possible that more than one adaptation may be needed for certain LO. Adaptations may occur in three different areas, namely: **appearance** where changes in the look and feel of the LO are made (i.e. display content of the LO in white font and black background in order for people with low vision to be able to see it), **content** where changes in language (such as different terminology or translation), educational changes (such as different level of difficulty or sequence of the constituent parts) and content updates (such as addition or removal of components) are made and **technology** where the adaptation of the LO to a different technical format is made in order to suit appropriately to the available technical environment (i.e. mobile environments).

**Aggregate with other LOs:** In this sub-step the instructional designers aggregate the LO with other(s) LO(s) and thus a new LO is created. The LOs used for aggregation may result from selection through the LOR or may be new LOs created from scratch. When existing LOs are used, then their disaggregation or adaptation may be required.

**Integrate:** At this step the LO is integrated into the environment that supports the learning activity in hand (i.e. integration in a LMS).

**Use:** At this step the LO is used in a specific learning activity by learners and/or teachers/practitioners towards the attainment of specific learning objectives.
Feedback: In order for the LOs to be retrieved and used effectively in different learning activities more information are required about how they were used in practice besides the information derived by their metadata records. A number of techniques are used in order for users to provide feedback in the objects of a repository. The most commonly used techniques are comments (referring to the context of use of the LO and its usefulness) and ratings (the use of star ratings and/or hit counters that illustrate the number of downloads of a certain LO give a good indication of users’ impression of the object).

Delete: People or organizations that are responsible for publishing a LO may decide that the LO must be retracted and therefore removed from the repository.

5. Conclusions

The main advantage of Learning Objects in Technology-enhanced Learning has been claimed to be their potential for component-based reusability in different learning settings. Nevertheless, there have been limited attempts to describe a consistent and explicit framework for LOs reusability that would allow organizations to assess the benefits of reuse and implement a systematic LOs reuse process. In this paper, we have investigated the issue of reusing LOs within the context of a technology-enhanced learning activities design and development, we discussed the limitations of existing proposal for LOs reusability processes, and we proposed an exhaustive and consistent reusability framework based on the international experience from the use of LOs in practice. This is an essential step for the development of metrics that can be used in measuring the cost effectiveness of LOs reuse in technology-enhanced learning.

6. References