

Creating by Reusing Learning Design Solutions

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Abstract. The widespread adoption of IMS Learning Design (LD) specification supporting actual educational practice largely depends on the fulfillment of an important requirement: teachers should be able to create their own Units of Learning (UoLs). Many of the proposed design processes for creating UoLs are based on the reuse of complete or non-complete learning designs at different levels of granularity. This paper introduces a comparison framework for conceptually analyzing and classifying reusable learning design solutions and processes that drive the creation of a ready-to-run UoL. The framework provides a comprehensible representation of such processes and units of reuse over two dimensions, namely granularity and completeness. It also offers a frame for discussing issues, such as the proper level of reuse, of existing and forthcoming proposals. Finally, it opens the path to other dimensions focused on providing language independence of learning designs.

1 Introduction

The IMS Learning Design (IMS LD or LD) [1] specification, released in February 2003, reflects a change in emphasis away from using the computer to display educational content towards using the computer to facilitate the teaching-learning processes. Nevertheless, the adoption of LD by teachers in real educational practice greatly depends on the provision of tools and processes capable of facilitating the creation of computer-interpretable Units of Learning (UoLs) [2]. These tools and processes should consider a broad range of types of teachers with different pedagogical and technical backgrounds as well as diverse didactical contexts: types of institutions and communities of practices.

The main problem refers to the fact that technical formalism (XML) and LD concepts are not familiar to the majority of the teachers. In this sense, the current trend in the development of LD editors is to hide the LD details by using concepts (and their representations) closer to the teachers' vocabulary. This type of editors is classified as high level or distant from the specification authoring tools [1,3].

Different approaches are being considered for providing concepts that are significant to teachers in the process of authoring LDs:

- Educational **taxonomies**, such as the taxonomy of learning activities used in [4].
- Pedagogical design **patterns**, which besides providing a conceptual common ground are a way of communicating educational expertise. Examples are the so-called CLFPs (Collaborative Learning Flow Patterns), which capture the essence of well-known techniques for structuring the flow of learning activities [5].
- **Frameworks** for the description of pedagogical specific LDs. The framework for the specification of collaboration scripts proposed in [6] is an example.

On the other hand, the teacher-friendly creation of UoLs can be achieved by reusing pre-existing learning design solutions at different levels of granularity (an LD activity vs. the whole flow of activities included in an LD) and completeness (a complete UoL vs. the bare bone structure of the flow of the activities of the LD), so that they can be incorporated into the creation of new LDs. To facilitate the understanding of the solutions before their actual reuse, they are presented to users using some of the aforementioned conceptual approaches as well as different types of graphical representations. Moreover, the diverse types of learning design solutions afford different types of design processes for their reuse and customization (assembly vs. refinement processes).

This paper introduces a *create-by-reuse framework* that elucidates different approaches for the creation of UoLs via the reuse of learning design solutions at different level of granularity and completeness. This framework is intended to provide criteria for comparing and classifying existing and yet-to-come proposals for creating UoLs, as well as their associated design processes based on a certain level of reusability. In addition, the framework provides a “tool” for discussing the proper level of reuse for user-friendly creation of UoLs according to teachers’ contexts and backgrounds.

The structure of this paper is as follows. Section 2 exposes the different types of reusable solutions that have been proposed for creating UoLs. The types of design processes that can be applied in the creation of these UoLs are discussed in section 3. Section 4 is devoted to discuss an example illustrating a design process that conforms to the framework. Finally, conclusions can be found in section 5.

2 Reuse of Learning Design Solutions

Several proposals have been identified for creating UoLs by reusing pre-existing learning design solutions at different levels of granularity and completeness. These two dimensions (granularity and completeness) provide an interesting way of classifying and comparing some of those relevant proposals (see Fig. 1). Furthermore, this two-dimensional space provides a way of grouping the existing and forthcoming proposals into four general (overlapping) sets:

- **Exemplars** are ready-to-run (complete) UoLs [7,8]. These UoL may embrace from one-activity session to a whole course. (i.e., finer or coarser-grained exemplars). In fact, the final goal of any design process carried out by a learning designer is obtaining an exemplar that fulfils the teaching-learning requirements. In other words, an exemplar contains all the information required to be enacted by an LD compliant LMS (Learning Management System).

- **Templates** are partly completed exemplars [8]. There may be also templates at different levels of granularity as well as at different degrees of completeness. Fig. 1 shows, as an example for illustration, that a template that represents a CLFP (for instance, the templates implemented in *Collage* authoring tool [5]) is more incomplete than the template that results from particularizing the pattern into an LD (actual description of activities, group-size limits, etc. but still without the resources that are needed in order to achieve a ready-to-run UoL).
- UoL **chunks** are portions of exemplars. The granularity of the chunks may range from a ready-to-use (complete) activity structure (including the activities, environments, resources it references) to a learning object (fine grained). In contrast to exemplars, chunks are not “playable” on their own.
- **Building blocks or components** are partly completed UoL chunks at different levels of granularity and diverse degrees of completeness. Figure 1 includes as an example “an abstraction of a pedagogic activity type”, which may be similar to the predefined activity tools that LAMS (Learning Activity Management System) [9] offers to users as components that can be graphically dragged and dropped to describe a sequence of activities.

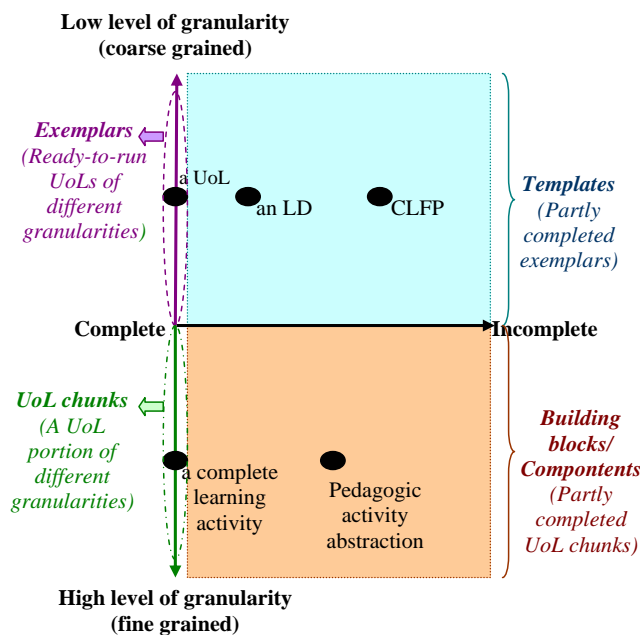


Fig. 1. Dimensions of the create-by-reuse framework: reusable learning design solutions at different level of granularity and completeness

Nevertheless, the design processes for reusing the learning design solutions in order to create UoLs are even more important than the reusable solutions themselves. Hence, further topics arise: What kind of design processes can be applied? To which extent do the processes depend on the type of reusable solution?

3 Design processes for creating Units of Learning

When creating UoLs, the pre-existence of re-usable parts of learning processes is the prerequisite. Yet, the challenging task is for the learning designer how to integrate these half-baked parts into a full-fledged learning design. In this section we will discuss different ways of achieving this and propose some design processes for the creation of UoLs that are supported by existing LD approaches and tools.

As defined in the previous section we consider templates, exemplars, components and chunks as the basic constituents for the creation of full Learning Designs. Because of their different nature we get a first separation of the creation process according to the activities needed to move forth to full UoLs:

1. Refinement: this activity is needed to reduce the abstraction level of constituents by adding concrete information about numbers of participants, roles, activity descriptions, resources, etc. This is the basic activity to move from templates to constituents that are closer to an automatically executable representation, which may take in several steps of reducing abstraction.
2. Assembly: this activity is needed to reduce the incompleteness of a constituent by combining several together or integrating them into a coarser grained process structure. This activity is especially suited for UoL chunks which are not “playable” on their own, but have to be integrated into other structures to be operational. While the mere sequencing of activities without dependencies between them is relatively unproblematic, more complex learning processes, that require interrelations between artifacts flowing through several activities or consistency of roles through phases, are more demanding. These relations have been discussed with proposed solutions in [10,11].
3. Modification: this activity may take place orthogonally to the other two. It usually reduces neither abstraction nor incompleteness, but changes some information inside the constituent. E.g. in exemplars the creation of a new UoL can be achieved by keeping the process structure, while exchanging the concrete resources to move to another domain of learning.

Fig. 2 shows these typical types of processes for creating complete UoLs. From right to left a refinement process moving from abstract to less abstract constituents, and from bottom to top an assembly process, that creates a larger scope structure from fine grained constituents. A modification usually would keep the position with respect to both abstraction and completeness.

The refinement and assembly design processes highlight the basic, stereotypical techniques to move towards complete UoLs. In practice it is very well imaginable and – from the perspective of a learning designer – highly desirable to have the option of mixing both approaches within one design process. To show the usefulness of our classification of design processes, we apply this conceptualization to two representative tools, Collage and LAMS (although LAMS models are not completely compatible with LD), based on the idea of creating by reusing learning design solutions.

As can be seen in the top right section of Fig. 1 CLFPs are highly abstract and thus incomplete representations of learning scenarios. Consequently refinement steps are necessary to create a complete UoL, such as customizing the pattern for the concrete scenario and binding the activities to specific tools and resources [12]. The first

refinement step produces an LD, while the second results in a UoL, ready to be played in an LD engine. This can be seen as a pure “horizontal” design process with refinement steps. On the contrary, the typical design process supported by LAMS is the assembly of LAMS building blocks (activity tools) into a process sequence by graphical linking of the activity tools. This type of design process can be considered the “vertical” assembly design process of Fig. 2.

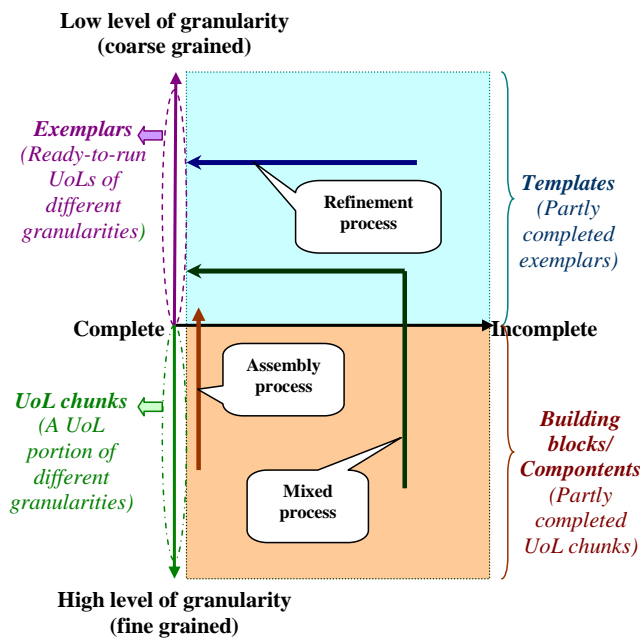


Fig. 2. Design processes for creating UoLs by assembling and refining learning design solutions

Collage also has the potential to use a “mixed” design process, by assembling different templates based on CLFPs into a more complex learning structure and then refining it by adding concrete information. As an example, a pattern (Jigsaw CLFP) could be combined/assembled with another pattern (Pyramid CLFP), so that one of the phases of the Jigsaw is structured according to the Pyramid [5]. This integrated template has to be refined in the usual procedure of Collage to produce a full UoL. This mixed process can be seen as an instance of the angular design process in Fig. 2.

4 Discussion: A Create-by-Reuse Example

Although learning objects are not “learning designs solutions” strictly speaking, they have been considered in the framework as the finest grained chunks, which need to be assembled with other components of different granularity (e.g. an activity building block) in order to reuse them for creating a UoL. In this case, the result of the

assembly is actually a refinement of the component: the learning object (e.g. a document) completes the component (e.g. an activity building block). “Refinement by assembly” can be thus understood as a type of mixed design processes.

On the other hand, the proposed framework envisages an interesting challenge: the connivance of learning design solutions formalized with different languages (e.g. the formalisms used in LAMS and IMS QTI for questionnaires) so that they can be assembled in order to generate an LD-compliant UoL (or eventually other type of UoLs using a different formalism). Therefore, the problem that design processes should address is not trivial. Not only do we need to assemble and refine learning design solutions at different level of granularity and completeness but we also need to transform formalizations. These ideas are illustrated with the following ad-hoc design process example, which is represented in Fig. 3.

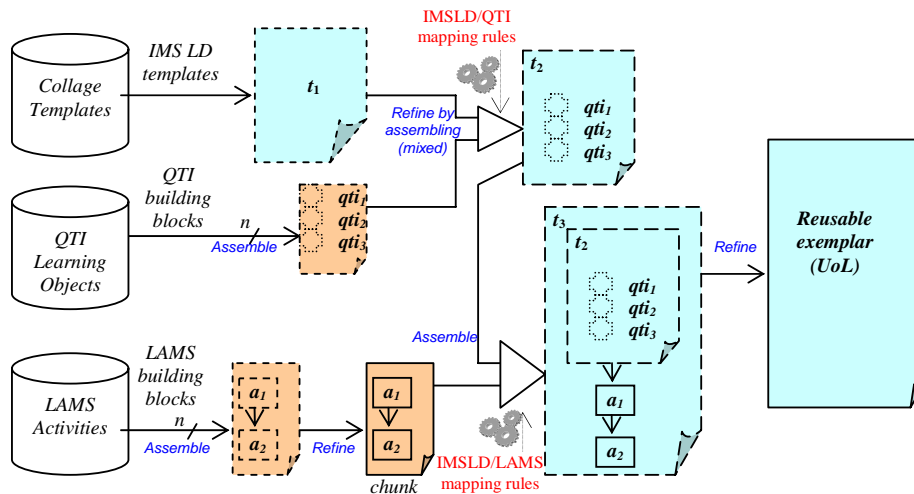


Fig. 3. Example design process in which various learning design solutions are integrated into refinement, assembly and mixed processes, according to the create-by-reuse framework

The process starts by searching Collage templates to select the Pyramid CLFP-based LD template (t_1), which consists of two incomplete activities (an individual and a collective activity). Then it proceeds to the selection of three QTI items, which are assembled forming a questionnaire. The template is refined into t_2 by assembling the questionnaire: the individual activity will consist in answering a questionnaire. In addition, two LAMS activities (which include the supporting tools) are assembled and subsequently refined with the necessary text that particularizes the activity. a_1 encourages the students to share resources and a_2 provides a forum for discussing. To particularize for example a_2 the title, the instructions and the topics of the forum must be typed. The resulting chunk is assembled with t_2 as additional activities according to the rules used to map LAMS activities into the coarser grained LD template. The outcome is the template t_3 , which still needs to be refined in order to be ready-to-run. Once the activities of the template t_2 are set up by adding the necessary text (the task of the collective activity, the grades related to each question of the questionnaire, etc.), a complete exemplar is achieved. This exemplar can be delivered as a UoL or,

according to the designer's criteria, be reviewed and modified. The complete process is graphically depicted in Fig. 4 according to the create-by-reuse framework described above.

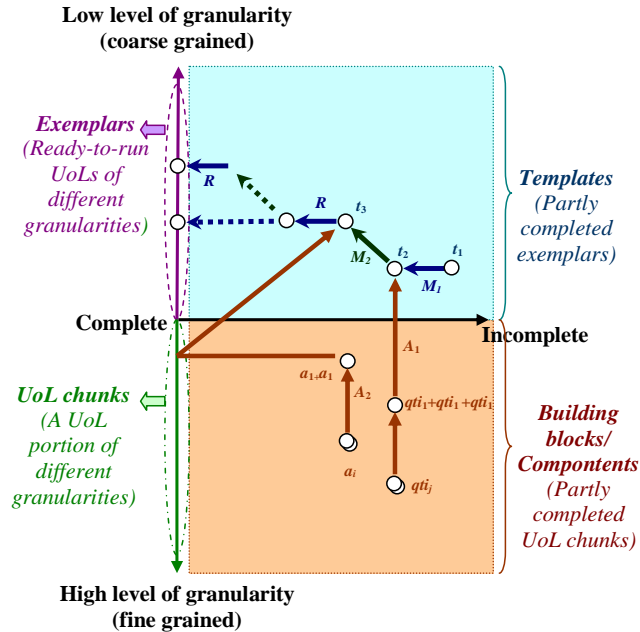


Fig. 4. Snapshot of the example design process that integrates assembly, refinement processes and mixed processes, in accordance with the create-by-reuse framework.

In the figure, point t_1 is the entry LD template that represents a coarse-grain LD abstraction (e.g. a CLFP) that is used as a starting point for transformations. Since t_1 is an incomplete LD template, it is situated above the horizontal axis. At the same time, selected learning objects and activities are composed by means of assembly transformations on the vertical dimension (A). The addition of item qt_{i_1} does not increase the granularity on M_1 (mixed process: assemble by refining) step, since it is used to fill in a gap of the t_1 template, so that t_2 is generated. t_3 results from the assemblage of t_2 and the chunk consisting of two already refined and assembled building blocks (a_1 and a_2). That entails increasing the coarseness with respect to t_2 as it can be appreciated in the Fig. 4. In this example, we omitted the modification processes of the framework, which are orthogonal to R and A and not explicitly represented in the two-dimensional figure. However, to envisage modifications, the input and output can be depicted sharing the same projection on the R - A plain.

5 Conclusions

Reusing learning design solutions with the aim of facilitating the creation of UoLs is expected to foster the adoption of the IMS LD specification. Several approaches have

been discussed within the LD community, which consider as reusable elements many different types of learning design solutions that can be assembled, refined or modified in order to generate customized UoLs. The main objective of the create-by-reuse framework proposed in this paper is to organize such approaches so that they can be compared and classified. On the one hand, it distinguishes the reusable solutions according to their level of granularity and completeness. On the other hand, the framework illustrates the basic types of design processes and their combinations, used to integrate the reusable solutions. In addition, it provides a conceptual frame to discuss several related issues, such as: what is the proper level of reuse for teacher-friendly creation depending on the institution, community, etc? Which types of learning design solutions are potentially more reusable, the coarser and/or the more incomplete? How can a proper understanding of the solutions before their actual reuse be facilitated? Furthermore, the paper envisages emergent approaches for creating learning designs when elements from more than one specification, formalism or model have to be combined in a single UoL, or they have to be transformed before being delivered to a specific non IMS LD-compliant LMS.

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