

## Representing learning design and classroom orchestration through atomic patterns

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### Abstract

*Learning designers have tried to find new ways of conceptualizing their designs in a graphical way, both to communicate with others and for themselves to reflect and create new designs. However, few representations of LD take into account how the activities will actually unfold when the design is enacted in a classroom. This paper proposes a representation for learning designs (especially collaborative learning designs using multiple ICT tools), which tries to depict how the activities are actually enacted by the teacher in the classroom, using the notion of "atomic patterns". This notion can be used by designers to provide more detail into how the different elements of the classroom ecosystem can be used, as well as by teachers to enrich their own learning designs. Initial evidence from teacher workshops in primary and higher education is also provided.*

### Introduction: LD representations and classroom practice

Learning design practitioners have used a number of verbal, textual, visual and data-driven representations to depict the most salient aspects of the designed learning activities, at different levels of granularity (see Conole, 2010, for a nice overview). However, no matter how detailed a learning design representation is, it does not unequivocally depict what should happen in the classroom as that learning design is enacted, e.g. by a teacher. Moreover, the same learning design can be implemented in many ways, some of them successful, some of them utter failures, depending on a myriad of contextual factors, minute teacher actions and unexpected events that are bound to occur in the classroom's "messy environment". This often calls for teachers flexibly changing elements of the design and their own performance, in a "disciplined improvisation" (Sawyer, 2004).

As the number of elements to be taken into account when designing learning for a modern classroom increases (multiple ICT and non-ICT tools, educational resources, different kinds of activities, pedagogical approaches and theories, etc), not only the practice of learning design is becoming more complex for design practitioners (and teachers who often fulfill that role), but it is also becoming more complex for the teachers that ultimately have to understand and enact those designs effectively. In such a modern classroom, teachers have to manage, in real time, different activities occurring at different social levels, making use of different tools and resources (thus, *orchestrating*, as coined by Dillenbourg, J rvel  and Fischer, 2009), on the basis of learning designs that often do not take many contextual factors of that classroom into account.

Up to now, most learning design representations only considered a few of these contextual elements (for obvious practical reasons, such as time constraints and cognitive load). Following our observations of teacher practice in primary and higher education (see Prieto and Dimitriadis, in this same workshop), this paper proposes a new form of representing learning designs which tries to take into account many of these elements of classroom orchestration. This kind of representation provides a more detailed view of a learning design's activities, focusing on the most prominent elements of classroom orchestration, such as the social level where the activities should occur, the tools and resources to be used, and especially *how* those tools should be used in the classroom in order to further the pedagogical aims of the design. This latter aspect is included in the design in the form of small-granularity, "atomic patterns".

This kind of representation has already been used in our research group as an *analysis tool* in order to understand how teachers' learning designs are transformed during classroom enactment (see Prieto et al., 2011a). In this paper, we will mostly focus on its benefits for the learning design field, which include making the learning design and its enactment *explicit and shareable* (one of the key principles of learning design, see Conole, 2010), or the good *mirroring* properties of the aforementioned atomic patterns, which are easily recognized and utilized by teachers. This kind of representation could also be developed further, into more complete computational representations of learning designs, in the vein of, e.g., IMS-LD.

### **The basic template: activities, tools and social structures**

In this paper we propose a new *graphical* representation of the learning activities to be enacted in the classroom, which can be seen as a variant of the "task swimlane" kind of representation, or the "link and node" representation, commonly used to provide a micro-level view of the learning design (e.g. spanning only a few hours of a lesson, see Conole, 2010). However, there are a number of interesting additional traits in this kind of diagram, which can be seen in Figure 1 (left):

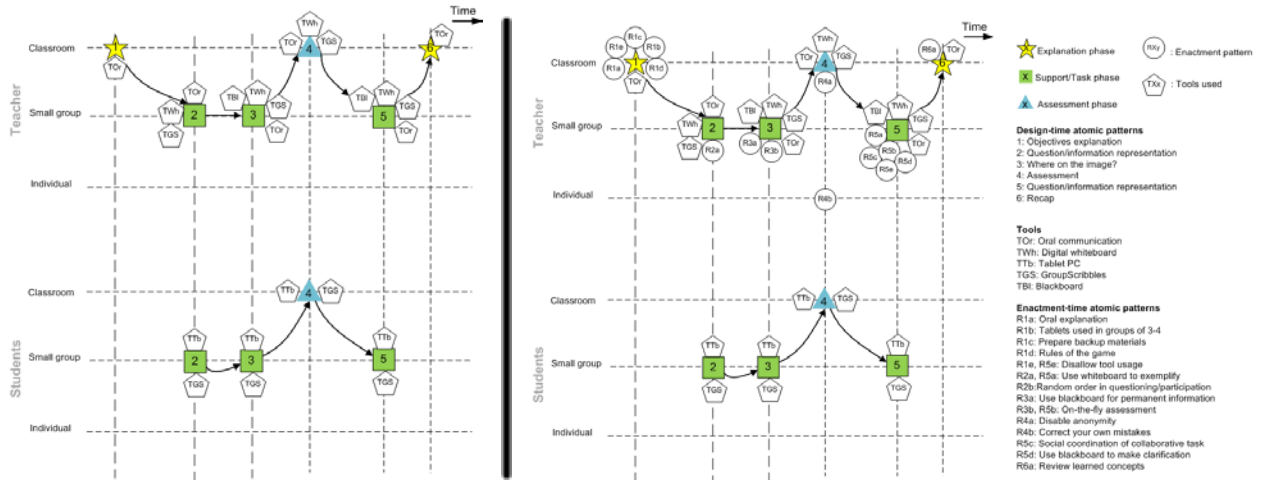
- In a similar vein as done in Dillenbourg and Hong (2008) and many other works on scripting, the representation depicts the different *social planes* where the learning activities may occur (individual, small group or class-wide), as horizontal lines where the different tasks are positioned, making the task flow jump from one plane to another.
- The different kinds of *activities and tasks* are depicted using colored, numbered nodes, to indicate different categories of tasks (explanation, support/student task, assessment), which are further explained in the legend (each number corresponding to one atomic design pattern, such as "Where is on the image?", see Prieto et al., 2010).
- The different *tools and resources* available in the classroom, which should be used for each task, are depicted as white, pentagonal nodes (i.e. TTb indicates the use of a Tablet PC).
- Since teachers and students often play different *roles* and use different tools throughout the different phases of the learning design, separate "swimlanes" are provided for students and for the teacher to indicate their respective activities and the tools used.

### **Flesh to fill the bones: adding enactment, atomic patterns**

The aforementioned template already provides a reasonably detailed description of many of the elements in the orchestration of a learning design. However, it still lacks one important element that constantly arose in our observation of teacher orchestration in authentic classrooms: the orchestration not only depends on which activities learners perform, or which tools they use; rather, the learning outcome is heavily influenced by *how* the teacher coordinates those elements through her concrete actions in the classroom (see Prieto et al, 2011b).

As described elsewhere (Prieto et al., in this same workshop), it was found that teachers' designs and enactments of collaborative activities using ICT showed a limited set of recurrent elements of practice (which we will term "atomic patterns"). Some of these patterns were used at design-time to design activities (a sort of implicit design patterns), while others did not appear at all in the designs, and were used in enactment-time to "fill the bones" of abstract or underspecified designs, as well as for improvisations in the face of unexpected classroom occurrences.

Our approach to representing learning design and classroom practice makes use of this notion of *atomic patterns*, representing them through the white, rounded nodes that are attached to each of the different phases in the teacher's task swimlane in Figure 1 (right). These nodes are further explained in the legend to the right of the figure (e.g. R2a indicates "Using a whiteboard to exemplify" a task so that learners understand the task and the usage of the related software tools).



**Figure 1:** Example representation of a learning design. Basic template depicting roles, social levels, tasks and tools (left). Complete representation using “atomic patterns” (right)

It is worth noting that the graphical representation in Figure 1 is only one of the possible ways of depicting these orchestration elements in a diagram following the aforementioned principles. The reader may refer to Prieto et al., 2010, Villagrà-Sobrino and Prieto, 2011 and Prieto et al., 2011a for variations of the same representation, each one emphasizing different aspects of our analyses.

**Practical representations: Using atomic patterns for design in teacher workshops**

As we have mentioned, the proposed representation is a useful analytical tool for researchers to investigate and describe what happened in the classroom, when compared to the original learning design. However, this idea of using atomic patterns in conjunction with other orchestration elements in representations also has other uses more directly related to the practice of learning design, either by teachers or by design practitioners. In fact, given that these atomic patterns are normally extracted from real classroom practice, and that they make direct reference to classroom objects, this kind of representations could be suitable as part of a “professional language to describe and communicate [teachers’] design ideas” (Law et al., 2011).

**Activity design:**  
elements of the Universe

- Brainstorming:**  
elements of the universe
- Classification:**  
planets, stars, these words by syllables
- Classification:**  
put the planets in alphabetical order

**Enriched activity design:** elements of the Universe

- A. Search for information on the Internet**
- B. Where is on the image?:** link images of the universe elements with its names
- C. Poll:** Classification criteria (order or size)
- D. Other classifications**
- E. Summary:** Paint a mural

**Figure 2:** Examples of teacher designs using atomic patterns, to enrich an existing design in a primary school teacher workshop (left) and in a university teacher workshop (right).

In our research group, we have been using this idea of atomic patterns in professional development workshops both in primary and higher education settings, as a tool to help teachers in designing and enriching collaborative learning activities with ICT, as well as part of a learning design approach where

different kinds of design patterns are utilized by teachers to design and reflect about the enactment of activities (see Dimitriadis et al., in this same workshop). Figure 2 shows two examples of teacher designs that use this notion of atomic patterns. As of this writing, one of these workshops with university teachers is being carried out, and more evidence of the use of this kind of representation by teachers in real learning designs will be provided at the ASDL workshop.

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