LDL: a Language to Model Collaborative Learning Activities

Christian Martel, Laurence Vignollet, Christine Ferraris, Guillaume Durand
Laboratoire Syscom, Université de Savoie, France
{christian.martel, laurence.vignollet, christine.ferraris}@univ-savoie.fr
guillaume.durand@etu.univ-savoie.fr

Abstract: The scenarization of educational activities, especially those that are going to take place within e-learning platforms, has for a number of years represented a major challenge for groups working to favor the emergence of educational standards. This paper presents LDL (Learning Design Language), a meta-model proposed to formalize scenarized activities. We particularly highlight the correct adaptation of this meta-model for modeling various collaborative situations.

Introduction

Today, it is easy to find "lesson plans" or "pedagogical scenarios" or "learning scenarios" or "learning scripts" made available on the Web by teachers themselves for their peers (Van Es 2004). These scenarios are usually described by a textual description giving links to resources, sometimes completed by an organization plan. Moreover, the progress made in the fields of semantic Web, architecture modeling and protocols of interoperability leads naturally the distance education designers to imagine opened, tailorable platforms that could be adapted to their users' needs. The scenarization of the activities is part of these new technical possibilities of tailorability offered to teachers. Researchers in this field are trying to increase the degree of educational freedom teachers have. To do so, they do not favor any educational model *a priori* in their models or tools. Teachers have the choice and the responsibility to decide on the organization and content of the computer-based activities they plan. It is probably for this reason that the scenarization of educational activities, especially those that are going to take place within the e-learning platforms, has for a number of years represented a major challenge for groups working to favor the emergence of educational standards.

The OUNL was a pioneer in this subject with its initiative of proposing the EML (Educational Modeling Language) meta language (Koper 2002). This meta language has been adopted by IMS and has resulted in the IMS-LD standard specification (IMS-LD). Even though EML has been adopted by IMS, there remain barriers to its adoption. Particularly, it is not always easy to model a collaborative learning situation using IMS-LD level B and C. Several teams (Hernandez et al. 2004, Nodenot et al. 2003, Ferraris et al. 2005) have so developed extensions to IMS-LD or competing meta models, tools and methodologies.

We have done like that, proposing an alternative meta model which is particularly well-adapted to modeling collaborative activities. This meta-model, called LDL (Learning Design Language), is the cornerstone of a larger project whose objective is to develop a complete editorial chain of learning scenarios: from scenario authoring to its execution using ICTs (Information and Communication Technologies).

LDL is described in this paper. In what follows, we will first give an example of what we call a learning scenario. Then we will explain what was our approach in designing LDL and in particular the main differences with IMS-LD. After, we will present our vision of learning design and the LDL components. We will then give a few information about the execution infrastructure that we have developed to operationalize and execute LDL-formalized scenarios, before concluding.

An example of learning scenario

The chosen example is inspired by a real lifelong learning scenario proposed by the "Centre National d'Enseignement à Distance" (the CNED, a French educational institution in charge of organizing distance training). It highlights the heterogeneousness of educational situations encountered by students during a course. CNED offers each year, under the condition to have the "baccalauréat" (a high school degree), a course in astronomy and astrophysics. This leads to a degree delivered by the University of Paris IX. Part of the learning objectives is to acquire a basic knowledge of astronomic observation and its means. Registered lifelong learners usually don't know each other. They may have different objectives: personal, civil, social and/or employment-related (Langlois 2003).

The narrative: during the course, each learner has access to the lessons one chapter after the other, according to a well defined progression. For each lesson, s/he has to learn it and to do exercises. S/He can communicate with her/his peers to get help. For instance, learners have to observe the sky with the naked eye; each learner has to make sketches of her/his planetary observations justifying theoretically their positions and movements. Each learner does the exercises and sends them to their teacher. The teacher annotates them, marks them and sends them back. If the learner has sent enough work to her/his teacher throughout the course with "good" marks, the administration gives her/him the authorization to start the examination preparation phase which consists of questions given one by one by the teacher to the group. Each time a learner answers, a new question is given to the group. Finally, the course is validated by a final examination.

Our approach

A teacher-centered approach

Contrary to IMS-LD, LDL has not been designed with the aim of supporting the industrialization of pedagogical activities. It has been defined to allow teachers themselves to design and describe these activities. Indeed, one of our general objectives is to make teachers' everyday work easier while using on-line environments and specialized software to operationalize and to execute learning scenarios. Our approach is thus teacher-centered.

An interactional and situated vision of activities

LDL is based on a different analysis of what the learning and pedagogical activities are. From our point of view, a pedagogical activity is not a process which can be broken down into a succession of tasks to realize. This is IMS-LD and other Learning Design languages approach. They have a hierarchical and componential view of an activity. On the contrary, we consider it as a set of exchanges occurring between the activity participants.

Teachers may organize and structure these exchanges within a given pedagogical context (the activity is situated). This context includes not only contents and pedagogical objectives but also, and above all, a set of rules which define the parameters of the activity (examples of such rules in the CNED example could be : "you can compare your exercise results with the other learners' ones before sending them to the teacher", "if you have difficulties in making the sketches of your planetary observations, you can contact the teacher by e-mail or by phone on Monday"). The activity resulting from this structuration unfolds in this context.

The intrinsically evolutionary and unpredictable nature of learning activities

An activity progresses through individual and collective positions taken by the participants within the exchanges (in the CNED example, such positions could be: "I have finished this exercise"; "we have answered this question"; "this exercise is too complicated"). These positions have an influence on the performance of the activity, as they are indicative of the participants' reactions and perception of the activity. So the teacher observes them with the aim of intervening to adapt the situation with regard to these reactions, by modifying the context, the exchanges or their structuration. A pedagogical activity is indeed intrinsically evolutionary and unpredictable: the teacher can only build an a priori description of what he/she wants it to be; he/she must then have the means of modifying and adapting it dynamically whilst it is being carried out. This supposes that he/she has at his/her disposal the means of observing the activity.

Taking into account canonical classes of situation.

Throughout their life, learners face numerous and varied educational situations. These situations differ mainly in the way they organize the relation between the teacher, the learner and the groups i.e. the team or the class to which both belong. According to these criteria, it is possible to distinguish typical situations:

- A frontal situation, in which participants have individual activities and no relations with the other participants, except with the teacher who oversees, stimulates, coordinates and controls. The teacher has a central position in the exchange and in communication.
- An open situation in which participants can cooperate freely with their peers or with the teacher(s). In these situations, each participant is supposed to produce results.
- A collective situation in which participants cooperate in order to solve a collective problem which has been given to them. In these situations, any participant's contribution is considered as the group's contribution.

The CNED example described above illustrates these three basic situations: individual ones coordinated by a teacher (i.e. frontal distant) in the course learning phase, open ones in the exercise phase and collective ones in the examination preparation phase.

As in the CNED example, real educational practices can combined these various forms with each other in hybrid educational situations that can evolve over time. From a scenarization point of view, to guarantee the teacher's freedom, the meta-model should make it possible to model all situations and their possible combination.

Requirements for LDL

LDL has thus been elaborated within this teacher centered approach and this interactional vision of a pedagogical activity, whilst taking into account its intrinsically evolutionary nature and the necessity of considering observation. Furthermore, it deals with the canonical classes of pedagogical situations to model, that we have described above.

It also takes into account the variable granularity of activities, allowing one to model simple ones (e.g. an application exercise) as well as more complex ones (e.g. a complete cursus). Finally, it considers the dependency criteria between activities: they may be independent or not. Indeed, the scenarization of educational activities addresses in particular an important question: how to coordinate learning activities with pedagogical ones ? These two kinds of activity interfere with each other. The first ones, dedicated to learning, are usually performed by learners. The second ones, dedicated to supervision and remediation, are carried out by teachers. From a conceptual point of view, these two activities are not subordinated to each other. But they are inter-related : what happens in the ones may have an impact on what happens in the others, and vice-versa. LDL has taken this particular feature into account.

Learning Design

We agree with R. Koper & al (Koper et al. 2005) that the learning design is the human activity of designing units of learning, learning activities or learning environments. From our point of view, a scenario is the specification of a learning activity. It specifies the « why, who (in terms of roles), where, when, how » related to this activity. It is the result of a learning design activity.

The previous example highlights that learning situations are usually complex. An educational modeling language is supposed to provide the means to describe various learning situations, and to specify the related learning activities. We call this the specification of a scenario.

Scenario, scenarized activity, operationalization, execution

A scenario is the specification of a future learning activity which becomes a "scenarized activity". To create a corresponding activity in a targeted environment, like the CNED educational environment, a scenario has to be "operationalized". This consists firstly in choosing the participants, then attributing roles foreseen by the scenario to the proper participants, and finally selecting the services and contents required by the scenario.

The execution of the operationalized scenario will provide the means (resources, services, tools, etc.) to the learners, teachers, tutors, etc. to take part in the activity. Other activities may take place simultaneously within the scenarized activity; we call these "spontaneous activities". Given their unpredictable nature, they cannot be specified in any scenario, neither can we control or follow them.

Scenario production

As such, the scenario is only an arbitrary notation system intended to describe the future activity. This notation has to be as independent as possible from the context of its execution (for reasons of interoperability). To produce a scenario, the first step is to design the conceptual model of its corresponding activity. The various components of an activity are gathered in a meta-model which establishes the concepts and the inter-concept relations. A model of the activity is built using the concepts defined at the meta-model level. For instance, the concept of role is defined at the meta-model level, whereas the name of the roles will be given at the model level. From its conceptual model the scenario can be automatically generated in a machine-readable language.

With LDL, the scenario design starts with: 1) the identification of its interactional structure, i.e. the way the exchanges are going to be organized, 2) the definition of the roles involved, 3) the definition of the arenas which are the places where the activities will take place, 4) the definition of the rules that the participants will have to follow, 5) the definition of the participants' positions i.e. the various points of view which they would have to express during the activity. These concepts are illustrated in Figure 1 and detailed in the following section.

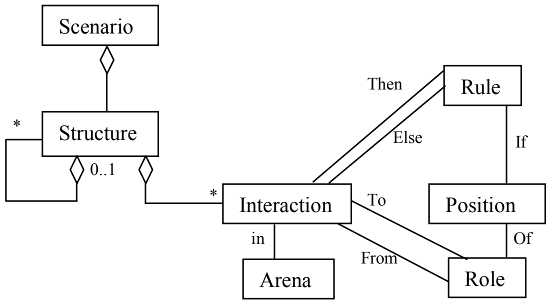

Figure 1 : A simplified UML representation of LDL

Learning Design Language (LDL)

LDL is an EML and thus respects corresponding updated specifications (Olivier et al. 2004). In this section, we describe its main concepts.

Activity structure

In the CNED example we can distinguish successive phases. Each phase organizes the progression of the numerous interactions between the participants: distance learning of the course, homework to be sent to the teachers, debate with their peers, etc.

In LDL, a phase corresponds to a *structure*. A simplified version of the CNED scenario is illustrated in Figure 2 (we have used the ModX graphic model editor to produce it (see Lepalec)).

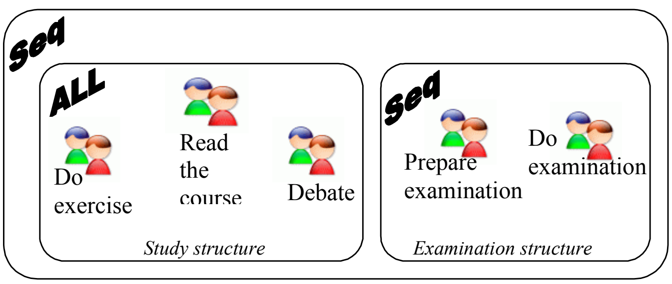

Figure 2 : Modeling the CNED example with LDL concepts – The structures view.

It can be broken down into a sequential structure of two phases: “study” and “examination”. In the “study structure”, the learner can play in any order: “read the course”, “do exercise”, “debate”. In the “examination structure”, the learner sequentially prepares the examination and takes it on the planned date. In each of these phases, the interactions are organized according to a parallel or sequential structure.

Three types of structure exist: 1) the “sequence” (“seq” on figure 2) in which the interactions play one after the other; 2) the “selection”, in which certain interactions are chosen from the set of interactions and played in sequence; 3) the “all” structure, in which all the interactions will be played without a predefined order. Thus a structure is a means of specifying either the order in which the interactions will be played (in a “sequence” structure) or the relative positions of the interactions ones compared to the others (in “all” and “selection” structures).

A structure can contain other structures, as shown in the example. The way to gather structures depends on the phases the designer of the scenario has specified. We consider the structure as the backbone of the scenario.

Participant interactions

The *interactions* fit into the structures previously described. They specify the exchanges the participants will have during the learning activity. They usually consist of verbal communication, document exchange and collaborative productions. They are situated: they occur in contents or via services. These interactions depend on the capacity of the places where they occur (for instance, a content can be read, a service can offer communication functionalities, etc.)

In its simple form, an interaction is an action from one participant to another in a specific place. The initiator is called “the addresser”, the other is called the addressee. The place where the interaction takes place is “the arena”.

The type and the number of interactions reflect the degree of cooperation between the participants. In our meta-model, an activity is reflected by an interaction. Thus, LDL is “intrinsically cooperative” in the sense that the activities modeled are based on participant cooperation.

Participant roles

In the CNED example, participants have “coherent” interactions. The ones who read the course, do the exercises and take the examination are the learners. The ones who write the course, annotate a piece of work and mark an examination are the teachers. A set of interactions reflects a *“thematic” role*. Thus, in LDL, a role is defined by its corresponding set of interactions. During the performance of an activity, a participant’s actions will be limited by the interactions which define her/his role.

Activity arenas

The activity *arenas* specify the places where the activity will take place. An arena can be either a service or a content. A forum, a search engine or a chat room are considered as service arenas. A course, an exercise, a photo album or a web site are content arenas. This spatialization guides the modeling and delimits the interaction perimeter. Participants interact in these arenas through the interactions specified by their roles. It is the means of situating the activity.

Rules : dealing with adaptation of activity performance.

The LDL concepts described above facilitate the design of learning activities in which participants receive instructions as to what they have to do. We propose to add the means to allow the adaptation of the activity’s performance with regard to the participants’ reactions.

To do so, the model includes *rules*. Rules are used to define the start and the end conditions of interactions and structures. They are also used to personalize the learning activities according to what we call participant’s *positions*. For instance, a rule can be defined to propose complementary lessons to a learner who has declared that s/he is not able to do an exercise.

Positions and observables : dealing with activity observation.

We have mentioned that allowing the adaptation of the activity performance requires observation. In addition, simply to know what is going on, participants, be they learners or teachers, will also need observation points. There are two concepts dedicated to observation in LDL: *positions* and *observables*.

A *position* reflects the participants' reactions and perception of the activity. It is a general concept which covers different notions such as: participant point of view, her/his availability, the difficulty of an activity, a mark, etc. It represents the value a participant associates with an activity concept.
The position value is tested in the conditional part of the rules. As rules control the activity's progression, participants can influence this progression through their positions.

An *observable* is a means of introducing observation points in the activity. For instance, the following entities are observable: interaction state (visible, started, stopped, etc.), structure state (visible, started, stopped, etc.), progress of the participant in the activity.

Observables are used to build different views on what is going on. In the CNED example, teachers can use this view to know who is having difficulties in which exercise. An observable can also be referenced by the scenario itself, as a position. A rule condition can refer to an observable. For instance, a rule could be: if a learner starts to prepare for an examination even though s/he has never sent any exercises, then notify the teacher.

LDL expressiveness

Modeling activities dependent on each other

We have mentioned above that activities in educational context may interfere with each other without being subordinated to each other, in particular learning and pedagogical ones. In LDL, the means of expressing this inter-dependance is to share positions between to activities. To facilitate this sharing, we have added a property to the position concept: the *scope* property.

As stated above, a position is linked to a participant and only known by her/him. It could sometimes be useful to let this position be known by others. For instance, the mark obtained by a learner should be known by all teachers and by the administration, the availability of a teacher should be "public", etc. In the example above, some of the learners' positions should be visible for the teacher in her/his supervision activity.

The scope can help to specify whether the position has to be visible for all the participants of an activity, for all the participants of a scenario, or for participants involved in other scenarios. We say that the scope is respectively one activity, the whole scenario or the execution infrastructure.

Modeling open situations and collective ones

At the beginning of this paper, we have proposed three canonical types of collaborative situations. The first one is easy to model with basic concepts of LDL. We have introduced another property to the position concept, called the *partition*, to facilitate the modeling of the other two.

In the open situation, participants have individual problems. Their position only holds for themselves. In the collective situation, one participant's position applies to every participant in the collaborative activity who has the same role.

The CNED example contains one collective situation: preparation for the examination. This consists in repeating the following: the teacher proposes a question to the group of learners preparing for the examination; when one learner gives the answer, it is considered as the group answer; then the teacher asks the next question. In a certain sense, in this case, the position of one participant represents the group position. The partition of the position is thus "collective".

The partition of a position can be "individual". For instance, in the lesson study activity, each participant has to take position individually (s/he does the exercise or declares that s/he will not do it).

Infrastructure and experiments

This paper would not be complete without mentioning the existence of an infrastructure dedicated to scenario execution. Called LDI (Learning Design Infrastructure), it features a player: the participant interface to LDI. This player gives a participant the means to interact via Internet through the contents and the services of a CSCL environment. The first developments have been made for the "cartable électronique" environment (electronic schoolbag - (see Martel et al. 2004)) used at the University of Savoie. Some experiments are in progress. They consist of auto-training scenarios and distance evaluation ones, using IMS-QTI exercises. The results of these experiments will be the subject of a future paper.

Conclusion

In this paper, we have presented LDL, a new language for modeling educational activities in order to produce executable activities in existing digital environments. LDL has been developed by the "scenario team" of SysCom Laboratory, in conjunction with researchers from the scenario team from Clips-Imag Laboratory in Grenoble (France) and the Pentila Corporation (http://www.pentila.org/).

It relies on a powerful meta-model which allows the representation of various situations, particularly collaborative ones, with few concepts. It natively integrates semantically grounded concepts to consider activity performance adaptation (rules, positions) and activity observation (positions, observables). It also take into account inter-dependence between activities which are not subordinated. This distinguishes LDL with respect to other meta-models like the one proposed in IMS-LD.

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