Towards a novel graphical editor for modeling Learning scenarios

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Abstract— **The IMSLD specification had emerged in 2003, with the aim of allowing learning scenarios design with regards to good and successful pedagogical guidelines. Since that time, many research works had been carried out to provide authoring tools and/or LMSs that implement it. So the IMSLD success does not only depend on its own principals but it greatly depends on tools implementing it. However some authoring tools and LMSs (which are considered as LD execution environments) lack some software quality characteristics as interoperability, flexibility adaptability, graphical interface usability,…**
But with the SOA oriented LMSs, the learning process should be considered as a business process where learning services are orchestrated to provide to learners the best learning experiences either individually or collaboratively.
In this paper, we present a novel approach and a graphical tool based both on the IMSLD specification and on MDA (Model Driven Architecture) transformations to Business Process Modeling Ontology (BPMO) notation.

Keywords- Learning Process, Business Process, IMSLD, BPMO, SOA based LMS, MDA.

I. INTRODUCTION

Information technology development had drastically impacted several domains including the educational domain. For instance, e-learning is the straightforward result of IT evolution. The e-learning is considered as a pedagogical approach using ICT (Information and Communication Technology) even in classrooms or over the internet in any place, at any time and at any pace.

Accompanying e-learning development, many standards have been defined and implemented by learning tools or environments, namely SCORM (Sharable Content Object Reference Model), LOM (Learning Object Metadata), IMSLD (Instructional Management Systems Learning Design), IMSLIP (IMS Learner Information Packaging),…and many other standards.

Nowadays, as the e-learning use had spread, great interest had been oriented to learning scenarios and the manner to design them, so to provide the best learning experience to e-learning users.

Many initiatives and research works has attempted to provide tools for authoring, executing, analyzing and monitoring learning processes or scenarios.

However, even if there are many developed authoring tools, they don't cover Instructional Designers requirements, during either design-time or run-time. Indeed, learning scenarios flexibility and compliance with IMSLD, services interoperability among different LMSs still represent pending and open problems that need to be solved.

With the emergence of many service oriented LMSs, we attempt in this paper to propose an approach which could allow, firstly, learning scenarios/processes design with regard to the IMSLD specification. Our approach will secondly, allow to automatically transforming, the designed scenarios to a Business Process Execution Language as BPEL or BPEL4WS, so that scenarios execution, analysis and monitoring are done in an equivalent manner to that of business processes.

Our proposal is specifically based on MDA approach, the EMF (Eclipse Meta-modeling Framework) and the WSMO studio platforms. The rest of the paper is organized as follows: The second section deals with Educational Modeling Languages (EML) and e-learning standards. The third section details our proposal. The fourth section provides through a case study a proof of concept, finally we conclude with our proposal advantages and we outline our future works.

II. EMLS (EDUCATIONAL MODELING LANGUAGES) AND STANDARDS

The e-learning standards have been created to ensure some kind of unification between authoring tools, LMSs and Instructional Designers methodology for designing efficient learning scenarios. For instance, three interrelated standards have been largely exploited in the educational domain. Those standards are respectively LOM [1], SCORM [2] and IMSLD [3].

LOM provides a metadata schema allowing pedagogical resources (learning objects/LOs) description for the purpose of LOs indexation, research and reuse.

SCORM aims both technically use and control over learning objects within a given LMS.

IMSLD is considered mostly as a pedagogical standard which is close to many Educational Languages. Its principal objective is to be more activity centric then the other standards. So, it considers an activity as actions to be done by persons either learners or staffs within an execution environment containing LOs and learning services and producing learning outcomes. Each activity has its own learning objectives and pre-requisites. According to IMSLD, a learning scenario may be designed within one several Units of Learning (UoL). Each "UoL" allows the description of a pedagogical method (approach) as a series of "Acts" and where each "Act" is a sequence of "Parts". A "Part" is a sort of "Role-parts" binding a role to an activity. IMSLD defines three conceptual levels: the level A contains the core concepts. The level B adds condition and so allows some kind of personalization or adaptability to learning scenarios. And finally the level C adds notifications allowing controls over learning scenarios execution.

Since the emergence of IMSLD, many LD compliant authoring tools and execution environments have been developed. Authoring tools allow Instructional Designers to design learning processes or scenarios resulting in a single zipped file named imsmanifest where the principal scenario is described within an XML file. Examples for those tools are: LAMS [4], COLLAGE [5], RELOAD LDE [6], ASK-LDT [7], CopperAuthor [8], CoSMoS [9] MOT+LD [10], ReCourse [11] and ALFANET [12].

Besides, execution environments called sometimes players or LMSs are no more than software that have the capability to parse and interprete the XML file and then prepare the learning space, by affecting roles and instantiating and binding services to activities. Examples for such players are RELOAD LDP [13], SLeD [14], Coppercore [15], Edubox [16]…, and for such LMSs Moodle [17], SAKAI [18]…

Many LMSs have their own players or they integrate players given previously as examples. Some others integrate also the authoring environment providing thus a global and complete solution for Instructional Designers, tutors and learners. The figure 1 illustrates the development and usage cycle of learning scenarios.

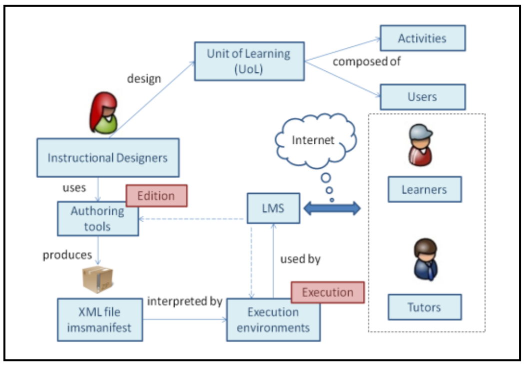

Figure 1. Development and usage cycle of learning scenarios.

The study that we have conducted about already existing tools have revealed the following conclusions which we summarize in table I.

TABLE I. COMPARISON STUDY BETWEEN TOOLS

Tools	Criterion 1 : Structure	Criterion 2 : IMS-LD supported level	Criterion 3 : To whom it is directed	Criterion 4 : Conformity with LD	Criterion 5 : Disponibility
RELOAD LDE	Tree	A, B and C	Experts in LD / Instructional Designers	Close to specification	Downloadable
CoSMoS	Tree	A, B and C	Experts in LD / Instructional Designers	Close to specification	Downloadable
MOT+LD	Diagram	A and B	Experts in LD / Instructional Designers	Away from specification	Downloadable
ASK-LDT	Diagram	A and B	Experts in LD / Instructional Designers	Away from specification	No downloadable
ALFANET	Tree	A	Experts in LD / Instructional Designers	Close to specification	No downloadable
ReCourse	Diagram	A, B and C	Experts in LD / Instructional Designers	Close to specification	Downloadable
Copper- Author	Tree	A	Experts in LD / Instructional Designers	Close to specification	Downloadable
COLLAGE	Tree	A	tutors	Away from specification	Downloadable
LAMS	Diagram	A	Tutors with expertise in LD	Away from specification	Downloadable

So, a very few tools could be used by non specialists and very few of them is compliant at the same time to IMSLD A, B, C levels. Services that could be offered to designed activities depend greatly on the execution environment. We notice that those services provide mostly communicative tools as e-mail, video conferencing, chat...

As a conclusion of this section, we can say that there is no relevant tool which is fully LD compliant and where flexibility, interoperability and adaptability of learning scenarios are granted.

III. PROPOSED APPROACH

As a response for preciously exposed problems, we propose the following approach which is based on a novel graphical tool and on MDA (Model Driven Architecture) transformation to the BPMO [19] notation. Our proposal aims, firstly, covering the LD A, B and C levels, and secondly, targeting Service Oriented (SO) execution environments. The figure 2 illustrates the seven steps of our approach.

We should stress that in the present paper, we only focus on step (1), (2) and (6), and that BPMO tool operates on its own process transformation to sBPEL and to BPEL4WS.

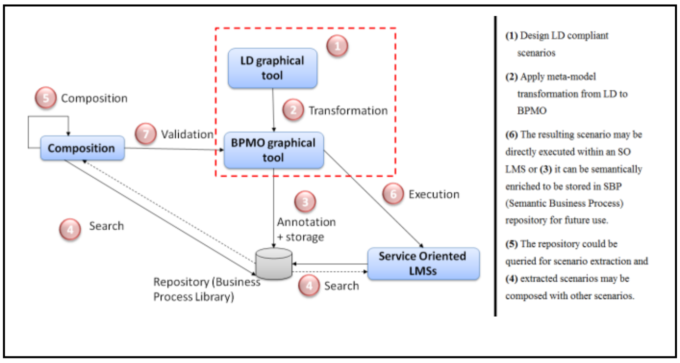

Figure 2. Proposed Approach.

So we start by exposing the MDA principals and how we use it in our approach, then we present the SOA based execution environment for the resulting learning scenario and finally we present our novel graphical language and its principal designing components.

A. *MDA principles and their relevance to our appraochs*

Model Driven Architecture (MDA) [20] is a software design approach for the development of software systems. It was launched by the Object Management Group (OMG). It starts with the well known and long established idea of separating the specification of one's system abstract functionalities from the details of its underlying technical platform. This approach promises a number of benefits including improved portability due to separating the application's knowledge from the mapping to a specific implementation technology [20].

MDA is based on a layered architecture with the meta-meta-model, meta-model, model and information layers. The MDA guide [21] defines a model transformation as "the process of converting one model to another model".

A transformation rule is a description of how one or more constructs in the source model can be transformed to one or more constructs in the target model. As illustrated in Figure 3, a model transformation program takes as input a model which is compliant to a given source meta-model and produces as output another model also compliant to the target meta-model. The transformation program, composed of a set of rules, should itself be considered as a model. Consequently, it is in turn based on a corresponding meta-model, that is an abstract definition of the used transformation language [22].

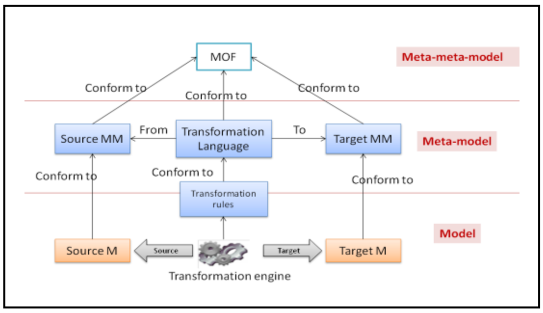

Figure 3. MDA principle.

B. *Source and target meta-models definitions*

With regards to the MDA approach, we had developed both LD and BPMO meta-models (figure 5) using the Ecore language. Those meta-models will be considered respectively as the source and the target meta-models, as illustrated in figure 4.

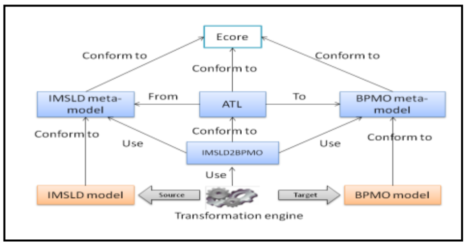

Figure 4. Application of MDA principles.

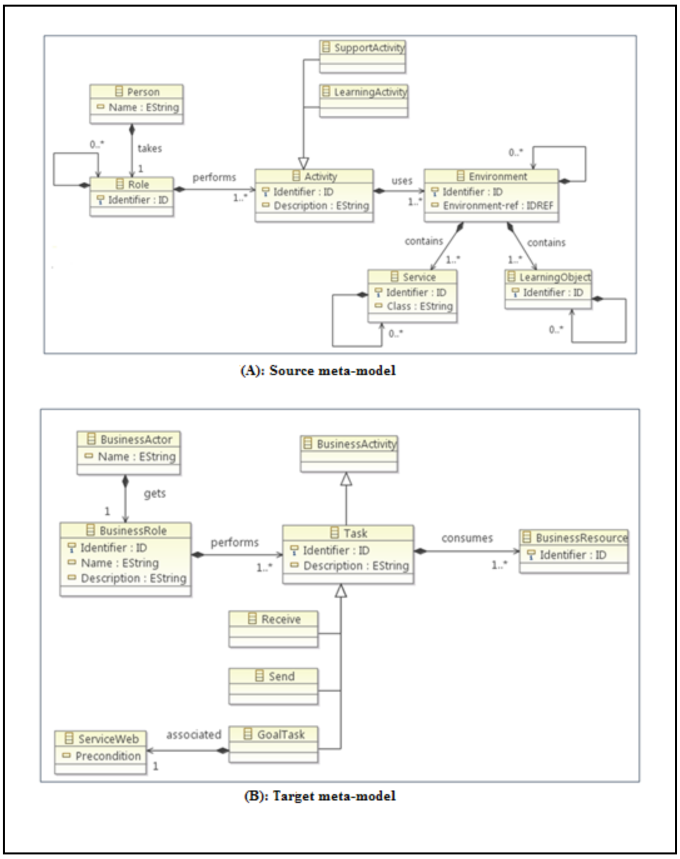

Figure 5. Source and target meta-models.

A deep analysis of both LD and BPMO concepts allowed us to deduce analogies and so to realize the required mappings. Table II illustrates mapping relationships.

TABLE II. MAPPING RELATIONSHIPS BETWEEN IMSLD AND BPMO

IMSLD Concepts	**Description**	**BPMO Concepts**
Person	identifies a person	Business actor
Role	Defines the types of participants in the unit of learning. It can be a learner or a tutor.	Business role
Activity	It is the basic element in the learning model. It links between roles, learning objects and services. There are three types of activities: learning activity, support activity and activity structure.	Task
Service	Specifies the services used during execution. There is a limited set of tools for sending e-mail, conferences, indexing and searching.	Web service
Learning Object)	Entity used in learning (web pages, animations, quizzes, etc.).	Business resource

Finally we have developed transformation rules using ATL language [19].

The listening 1 illustrates an excerpt of the file containing developed transformation rules.

Transformation 1

```
rule Person2businessActor{
      from a:LD!Person
      to b:BPMO!BusinessActor(
            Name<-a.Name)--}
```

Transformation 2

```
rule Role2businessRole{
      from c:LD!Role
      to d:BPMO!BusinessRole(
      Identifier<-c.Identifier,
      Name<-c.Role ,
      Description<-''
            )      ,
            dd:BPMO!BusinessActor(gets<-c.performs)}
```

Transformation 3

```
rule Activity2Task{
      from e:LD!Activity
      to f:BPMO!Task(
       Identifier<-e.Identifier
            ),
            ff:BPMO!BusinessRole(performs<-Sequence{e.uses})--}
```

Transformation 4

```
rule Services2webServices{
      from g:LD!Services
      to h:BPMO!ServiceWeb(
      Precondition<-g.Identifier       )}
```

Transformation 5

```
rule LearningObject2BusinessResouce{
      from i:LD!LearningObject
      to j:BPMO!BusinessResource(
            Identifier<-i.Identifier)}
```

Listening 1. Developed transformation rules

C. The SOA based Execution Environment

As LMSs have evolved towards more service oriented architectures, we have chosen in our approach to target this kind of LMS. For instance, the learning scenario will be defined as a chain of composed or simple Web services and will executed by a BPEL4WS engine provided by the web services infrastructure.

The figure 6 illustrates this kind of execution environment where the learning scenarios expressed in BPEL or BPEL4WS language is considered as the principal input for the SOLMS.

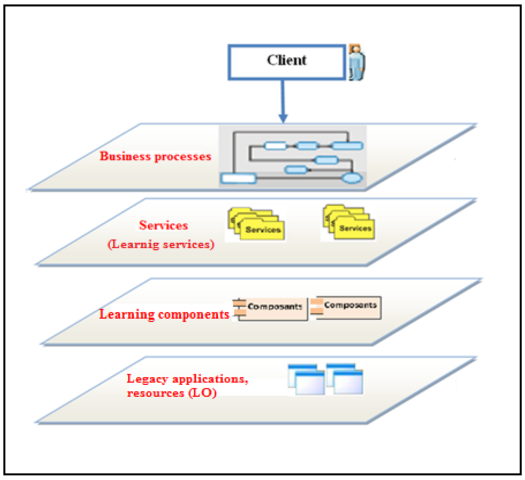

Figure 6. SOA architecture.

D. Principal Components of the Graphical Language

The semantics and syntactic aspects of our language are compliant to IMSLD specification. So, all representational graphics correspond exactly to those found in IMSLD concepts. The palette containing the graphical elements is represented in the figure 7.

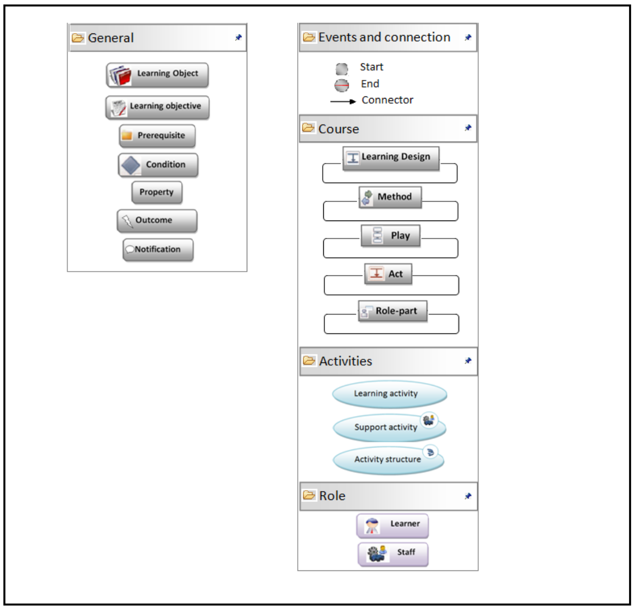

Figure 7. Palette containing the graphical elements .

IV. CASE STUDY AND EXPERIMENTATION

We present in this section, a sample example designed with our graphical tool. This learning scenario has the learning objective to allow learner to participate actively in a discussion about a proposed subject. The learner use to do this activity in the forum services. So, the teacher (or tutor) introduces steps to be followed by the groups of learners. Then, he/she assigned a reporter role to one member of each group of learners. Then, each learner should place a comment or an answer to discuss posts in the forum. Finally, each reporter should make a synthesis which is the result of negotiation between all members of the group and present it to the tutor.

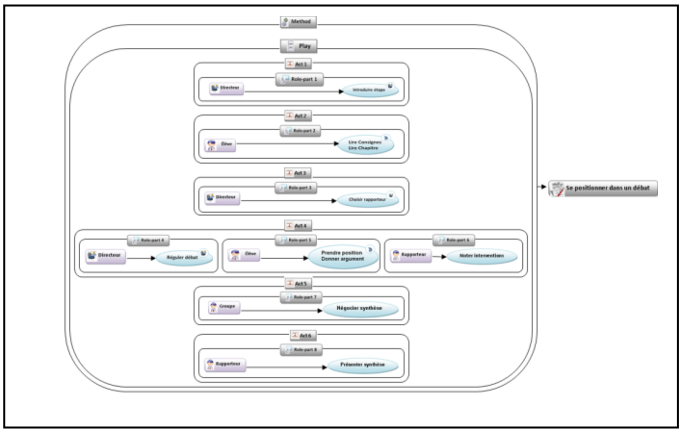

Figure 8. A learning scenario sample.

After designing the sample scenario, step (1) and (2) of our approach are carried out to obtain the BPMO corresponding sample as illustrated respectively in figure 9 and 10.

We should stress that major advantages of this approach is that it could be also applied to legacy IMSLD compliant scenarios.

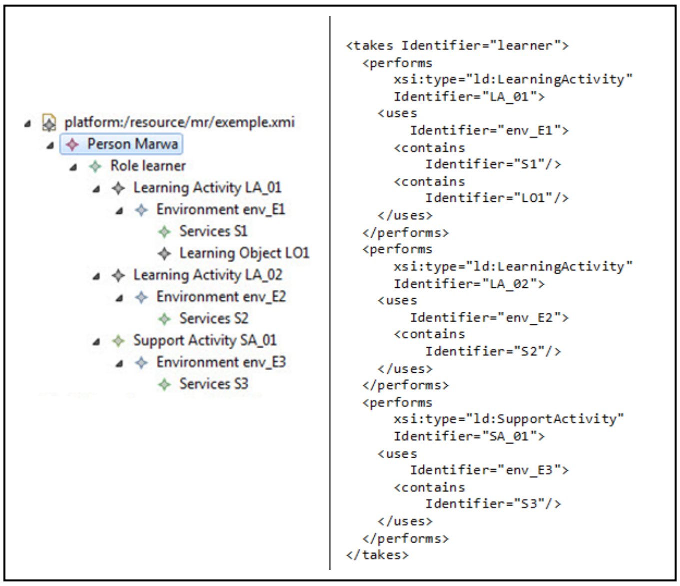

Figure 9. Excerpt of source model code.

The execution of the ATL file containing transformations rules produces an XML file: the target model.

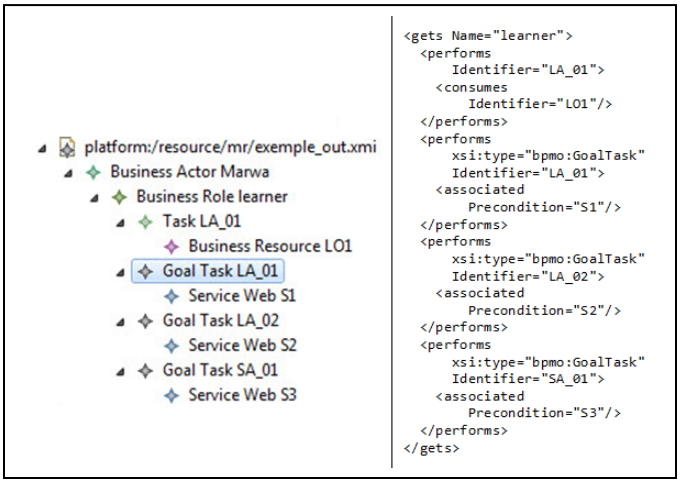

Figure 10. Excerpt of target model code.

V. RELATED WORKS

The modeling problem of IMSLD has been dealt in many ways by different authors.

Authors in [23] state that learning systems using IMSLD, lack ability to substitute resources in an easy and transparent way, and furthermore, to provide a rich and diverse pedagogical experience for learners. Therefore, they propose to use the SOA approach in order to implement dynamically diverse, distributed and heterogeneous learning resources and services.

The authors in [24] criticize the use of different representations in learning processes. As BPMN is considered a de-facto standard which presents a common human understandable notation, they propose the ability of using BPMN as a common representation notation for learning flows modeled using the Business Process Execution Language (BPEL) and present an algorithm for transforming BPEL Workflows to IMS Learning Design but only LD Level A was considered.

The first work is almost close to our approach as it considers the SOA execution environments the most suitable for adaptability, flexibility and interoperability.

However the latter, considers BPMN more suitable than LD. Conversely, we consider LD as the principal language and allow transformations to BPMO to take semantic advantages of this language.

VI. CONCLUSION

In this paper, we have proposed an approach and a graphical tool for modeling learning scenarios which are IMSLD levels A, B and C compliant, and whose execution may carried out in a services oriented environments.

We have conducted an initial evaluation of the graphical notation included in our approach and the transformation from IMSLD to BPMO has been tested over 10 different scenarios which were correctly transformed.

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