Supporting the Specification of Educational Modeling Languages and Learning Scenarios with a Domain-Specific-Modeling Approach

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REDiM Project
(Model Driven Reengineering of Technology Enhanced Learning)
LIUM lab
(Computer Science Laboratory of Le Maine University)
Outline

1. Research context: Instructional Design & MDE
2. Categorization: the 3-leaf domain clover
3. Towards Domain-Specific Modeling
4. Summary and ongoing work
Research Context: instructional design and learning scenarios

- One standard
  - IMS-LD (*Learning Design* from the IMS consortium)

- Some instructional design languages
  - EML (*Educational Modeling Language*) or VIDL (*Visual Instructional Design Language*)
  - eg.: CPM, E²ML, coUML, LDL, MOT+, poEML, etc.

- Some tools
  - Editors, Players, *Learning Management System* (LMS), etc.

- Some reported observations
  - Lack of user-friendly tools for end-users (teachers, designers, ...)
  - Need for languages and tools
    - adapted/adaptable to communities of instructional design (terminology, notation, etc.)
    - Providing computer-based facilities for reusing/exchanging scenarios, interoperability, executability, etc.
Research Context: Model Driven Engineering

• History
  ▶ Generalization of the MDA (OMG) specification for all technological spaces: OO, XML documents, DataBases, Ontologies

• Main ideas
  ▶ Systematic use of models as primary engineering artifacts
  ▶ The final system is developed by successive models transformations from a high level of abstraction towards platform-specific models, guiding code generation

• Principles
  ▶ Modeling, Meta-modeling, Capitalization, Abstraction, Separation of concerns...

• Tools
  ▶ Meta-model/language definition, transformation models tools, code generation, weaving model tools, \textit{generation of domain-specific model editors}, etc.
MDE and learning scenarios

• Some instructional research works dealing with MDE principles

  ▶ The CPM language
    • a UML-based visual language for Problem Based Learning situations
    • models transformation from CPM models to IMS-LD compliant models

  ▶ The tools and techniques from the Bricole project
    • a MDE CASE-tool (ModX) for designing any kind of scenarios
    • model transformation application (Gendep) to set up a Learning Management System (LMS) from any IMS-LD-compliant scenario

  ▶ The MDLD environment (*Model-driven Learning Design Environment*)
    • editor helping learning designers to generate units of learning conformed to IMS-LD by graphically specifying BPEL-oriented modeling
Observations from the application of MDE to learning-scenarios

- **Models** correspond to
  - the various learning scenarios produced in accordance to the different phases of instructional design processes

- **Meta-models** correspond to
  - the terminology defined for the used EML/VIDL

- **Final system** correspond to
  - the final learning situation relying on system and human artefacts (not only code)

- **Separation of concerns** are applied with
  - many points of view (didactics, pedagogical, structural...) available
  - difficulty to separate LMS-dependent/independent learning scenarios

- **Omnipresence of the business learning domain**
- **Omnipresence** for the need of graphical representations

⇒ **Some possible analogies but some specific constraints**
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The 3-leaf domain-clover categorization for EML/scenarios

- 3 categories according to the business learning domain and objectives targeted
  - Practitioners-centered Scenario
    - **Terminology** = the one shared by a community of practitioners
      (in relation to some pedagogical theories, didactical fields as well as specific references to the LMS they use)
    - **Objectives** = act as a design guide, support of thinking/communicating
  - Abstract Scenario
    - **Terminology** = high-level abstraction for supporting pedagogical diversity + independence from any LMS
    - **Objectives** = exchange/interoperability
  - LMS-centered Scenarios
    - **Terminology** = specific to a LMS
    - **Objectives** = act as guide for manual or semi-automatic configuration of the LMS platform
The 3-leaf domain-clover categorization for EML/scenarios (2)

- Two-complementary formalizations for each category
  - Visual/graphical notation
    - For a human-readable scenario interpretable by practitioners
  - Textual notation (XML)
    - For a machine-readable scenario interpretable with no ambiguity

- Two kind of transformations for scenarios
  - Extra-domain (terminology change)
    - When: from one category to another or between 2 different EMLs of the same category
    - For what: exchanging with other communities of practitioners or for obtaining the objectives of the targeted categorization
  - Intra-domain (notation change)
    - When: between EMLs of the same categorization that share the same abstract syntax but differ from the concrete syntax (notation)
    - For what: adaptation to the public (machine/human) targeted by the transformation
Schematization

Practitioners-centered Scenario

Abstract Scenario

LMS-centered Scenarios
Positionning of existent research works on EML/tools/LMS
Tooling needed to support our domain-oriented instructional design

- Tools and techniques needed to support emergence of communities of practice from our 3-categorizations
  1. To define domain-oriented EML/VIDL
     - Metamodelling techniques for specifying the terminology
     - Techniques for specifying human & machine-readable notations
  2. To graphically define learning scenarios (user-friendly editors)
  3. To realize the *intra* & *extra* learning scenarios transformations
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Domain Specific Modeling - DSM

• Definition
  ▶ Software engineering methodology for designing and developing systems
  ▶ DSM involves systematic use of a graphical domain-specific language (DSL) to represent the various facets of a system
  ▶ DSM languages tend to support higher-level abstractions than General-purpose modeling languages

• Approaches and tools
  ▶ Software Factories + Visual Studio (Microsoft)
  ▶ MetaEdit+, ATL, TIGER
  ▶ Eclipse modeling projects projet: EMF, GMF...

• DSM approach is applicable to our 3-domain categorizations
• DSM tools cover all the highlighted needs
Experimentation of EMF/GMF

- Objective of the exploratory experimentation
  - Providing practitioners with a UseCase-like visual editor for specifying Learning activities and roles performing them into learning phases

- Results
  - The metamodel
Experimentation of EMF/GMF (2)

- Visual editor, 100% EMF/GMF-generated (no hand-coding)

- XMI/XML serialization of produced learning scenarios

```xml
<?xml version="1.0" encoding="UTF-8"?>
    xmlns:activities="http://www.ict-dim.org/activities">
    <phase name="Act2">
        <activities name="Exploit available information to draw conclusions"/>
        <activities name="Reciprocal teaching" nextActivities="//@phase/@activities.2"/>
        <activities name="Forum posts analysis"/>
    </phase>
    <actors activityRealized="//@phase/@activities.0" name="Investigator" super="//@actors.1"/>
    <actors activityRealized="//@phase/@activities.1" name="Learner"/>
    <relations label="includes" source="//@phase/@activities.0" target="//@phase/@activities.1"/>
    <relations label="includes" source="//@phase/@activities.0" target="//@phase/@activities.2"/>
</lduc:Scenario>
```
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Summary and ongoing works

- Proposition of a conceptual framework for the application of MDE principles to scenario-based instructional design
  - 3 categorizations for scenarios and languages reflecting different communities of practices sharing a same business learning domain towards specific objectives
  - 2 notations per category to provide human and machine readability
- Domain Specific Modeling orientation to support our proposition
- DSM tooling can be helpful for
  - Easing the emergence of community of learning design practices
  - Supporting the building of user-friendly & visual learning editors
- Present and future works
  - Deeper experimentation of the Eclipse GMF
  - Experimentation of learning scenarios transformations with the Eclipse ATL tool
Thank you!

...Any questions?

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Research context: our approach

• REDiM project
  ▸ Instructional design and learning scenarios
  ▸ Teachers, acting as designers, are the targeted end-users

• Postulate
  ▸ The application of Model Driven Engineering (MDE) theories and practices is pertinent and useful for instructional design processes dealing with learning scenarios