A PATTERN-BASED AND TEACHER-CENTERED APPROACH FOR LEARNING DESIGN

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ABSTRACT

Teaching is changing in deep, due to, on one hand, the evolutions of the society expectations and, on another hand, the widely spreading of new technologies. By the way, teachers and trainers need now to structure and formalize their internal designs and should become designers but do not have the competence. We aim to help them during the instructional design process. In that way we propose some methods and tools to support the scenario design activity and the implementation of the resulting models. We present an adaptive user-centered pattern-based learning design approach and the editor tool to support it. A case study is proposed to illustrate the design process.

KEY WORDS

Educational scenario; model-driven engineering, domain-specific modeling; User Modelling; Adaptation

1. INTRODUCTION

Teaching is changing in deep, due to, on one hand, the evolutions of the society expectations and, on another hand, the widely spreading of new technologies. By the way, teachers and trainers, who are used to design their learning scenario with internal - non expressed practices, need now to structure and formalize their internal designs as models able to be implemented. They should become designers but do not have the competence and most of the time need specialists (e.g. pedagogical engineers) to help them during this scenario design activity and to implement resulting models.

This paper presents an adaptive user-centered pattern-based learning design approach. A pattern-based approach facilitates the design and the reuse of implementable scenario by a learning community of practice [3][6]. The approach is user-centered and adaptive as teacher is the principal actor involved in the design process but helped/guided during the elaboration of learning scenario according to his/her design practices. We aim to propose methods and tools to support teachers during the scenario design activity.

The main research question of this paper is about the feasibility of an adaptive pattern-based design approach to deal with the design and the reuse of learning scenario by teachers. The originality of our approach comes from (1) the use of different types of Patterns for specific design tasks and (2) the contextual guidance of the design.

The first section presents the scientific groundings of this work. We propose then a design process based on the use of patterns and on adaptive techniques. This process is illustrated in the third section by a case study. The conclusion synthesizes our results and discusses on future works.

2. THE RESEARCH CONTEXT

The literature has proposed different approaches which deal the instrumentation of instructional design, and specifically learning scenarios centered.

The well-known modeling approach by the help of Educational Modeling Languages (EML), as the IMS Learning Design specification [1] leads to enable the design of computational models (in the meaning of understandable by a computer) which could be enacted by compliant systems. However these specifications are not really usable by teachers and do not enforce design processes that support the creation of pedagogically sound designs [2]. Another approach is to allow designers (may be assisted by modeling specialists) to define their own EML by specifying a domain-specific language and to use it for building their scenarios [3] [4]. Our research work is based on this second approach and states that teachers are able to build their learning scenarios by the uses of patterns.

A design pattern is focused on a well-known problem and should provide its most common solution related to a given context, which is illustrated with diagrams or figures. A design pattern's approach is well-suited in design based research in education as it is sensitive to complexity and context-dependence [5].

Our engineering approach aims to support practitioners (classroom teachers) in their day to day pedagogical design tasks. The learning design patterns are a way of collecting "best practices" in learning, providing assistance to novice practitioners by communicating a learning expertise. In that

way, an authoring tool could help the design of pedagogical situations, by the use of design patterns gathered into a library [2]. Existing relationships between patterns should be described to facilitate their use/reuse.

These design patterns should allow further the definition of learning scenario in different learning situations in terms of objectives, competencies, domain, learning method, activities, resources, observation needs ... Some examples of learning patterns are proposed in the E-LEN projects [6] or the pedagogical patterns project [7].

COLLAGE [9] proposes a pattern-based visual design approach implemented in RELOAD [8], an authoring tool based on IMS-LD.

The research contribution we present in this paper is based on another pattern based approach that leads to devote specific patterns to specific design tasks (see infra.). Morever, patterns may be expressed in the teachers' business language [3] [4] (e.g. within their own business concepts and representation model).

Even if we do not yet aiming at creating productive models (e.g. operationalisable scenarios), this feature underpins our work. Thus, we have chosen to base the approach we propose in a Domain Specific Modeling (DSM) [10] framework which is a robust software engineering approach to deal with this Technology Enhanced Learning (TEL) context [13].More specifically, we have chosen to develop with EMF (Eclipse Modeling Framework) and GMF (Graphical Modeling Framework) to implement the DSM approach [11].

Another part of the research question is about adaptation of the pattern-based design. Teachers, as they should become designers, could be guided in their design activity. The pattern approach we propose is user-centered. User models and user modeling are key elements for personalizing interaction. User modeling is motivated by differences in individual user's needs and characteristics and heterogeneity between different groups of people [14]. We address an automatic user modeling approach where the user's model is defined during a tool design activity session from user's characteristics (user profile, user's preference, competency, level of activity, level of competence …). Those user's characteristics are relevant tracks to collect and will be used to help teachers to manage their learning design activity. An analysis solution of these tracks is needed to adapt the system to the user's design needs. For structuring tracks from row data, acquired and provided by the system during a design session, to indicators (something significant for its user), we have used the Usage Tracking Language (UTL)[12] which allows to model indicators as patterns and to calculate them at real time.

3. PATTERN-BASED AND TEACHER-CENTERED APPROACH

3.1 Meta-model of Patterns

According to the DSM approach, a meta-model (figure 1) has to be defined to describe the language allowing to compose or merge patterns with different formalisms. The purpose of this meta-model MOF compliant (Meta-Object Facilities) is to be used to generate an editor tool.
A study of the TEL domain combined to a review of the type of patterns available in software engineering, leaded us to select the following four types of patterns, thus the four concepts of a meta-model of patterns:

- *Pedagogical Patterns* are well-suited for describing learning objective or strategy. They are structured around *Forces* (how forces or constraints interact on pattern), *Resulting Context* (the result after the pattern has been applied) and *Rationale* (why one has selected this pattern).[16]
- We have chosen *Analysis Patterns* for describing material or human resources because of their structure which allows to define the use of a material or a role. [17]
- *Process Patterns* could describe the activities and the tasks realized as a workflow of the actions or sub-tasks.[18]
- *Design Patterns* are used to characterize the learning situation. Design Patterns are usually composed of several sections: *motivation (*description of the problem stated and the context where the pattern can be used), *participant* (list of classes and objects used in the pattern and their design role) and/or *collaboration* (description of the way classes and objects used in the pattern interact with each other).[19]

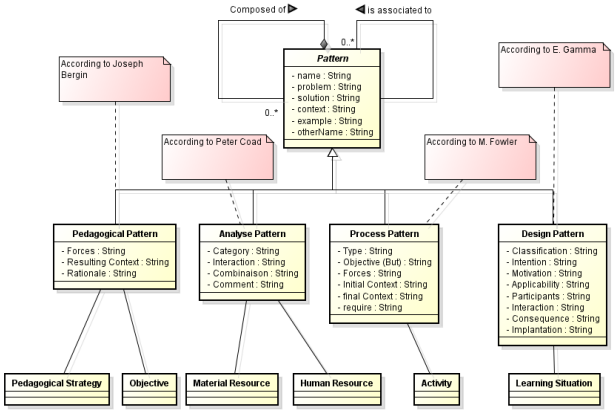

Figure 1: Meta-model of Patterns

3.2 The Design Context

To facilitate and guide the designer's task, an edition tool has to collect information on the design context and to adapt patterns to the purpose of the design session. This information relies to a set of indicators (UTL meaning: a significant datum which qualifies the activity, here the

instructional design task) which falls into five facets characterizing the design context. :

- *The User Profile* is made of information on user and editing tool configuration. As an example, a registered information of this profile is for instance the level of adaptation proposed by the tool and/or fixed by the designer (automatically, with user's confirmation, minimum adaptation ...)
- *The Learning context* qualifies the learning strategies defined by the designer.
- *The Institutional context* is a set of information on the constraints and the limits stated by the institution (classroom, materials ...).
- *The Domain* facet gathers the information concerning the concepts of the learning domain. An example of domain indicator is the "Concept in the Domain Vocabulary". This indicator checks if a concept used as a property for qualifying a given pattern is part of the current domain facet. This is operationalized by a simple toggle rule as "if the current concept is in the vocabulary, then search a pattern containing this term".
- *The Context of use* gathers information during the designing session in order to qualify the nature of the task.

Indicators of the design context cannot be strictly related to one of these facets which are interrelated and some indicators can feed several facets.

3.3 The Learning Scenario Editor

The editor we have developed is generated into the EMF-GMF framework, from the meta-model of Patterns (see figures 1 and 4). This editor allows the teacher to design a learning scenario by using a domain-specific visual language and by organizing and instantiating patterns. Upon this editing tool is added the adapting system able to capitalize the design contexts, and to adapt the domain-specific models and the editing interface, according to the DSM features of EMF/GMF. This interface allows the designer to visualize the patterns he instantiates as frames divided in three boxes: one for the pattern name, one for the statement of the problem and one for the graphical representation of the solution (Figure 4-A). A toolbox (Figure 4-B) provides the design primitives. Finally, information concerning the pattern is also accessible through the tab property (Figure 4-C) by which GMF characterizes each object.

3.4 The Design Process

When designing a learning scenario, a teacher can elaborate a solution by combining the four types of patterns allowed by the meta-model (see Figure 1).

The design process is iterative and consists of the following steps (Figure 2):

1 – *Instantiate the specifying requirements pattern*: the teacher has to define the requirements of the pedagogical situation (objectives, resources, tools, learning strategy, actors, roles, etc.);

2 – *Select a pattern*: the teacher can choose an existing pattern or create a new one. According to the pedagogical context, the teacher defines parameters to select the most relevant pattern. He can choose one pattern among the four types of patterns proposed by the editor: a design pattern for specifying learning situations, an analysis pattern for human or material resources, a process pattern for tasks or activities or a pedagogical one for objectives.

3 – *Merge the patterns*: The teacher has to associate the selected pattern to the ones he has already selected during previous iterations. The scenario is updated with the selected pattern and both user's actions and pattern properties are analyzed in order to infer indicators.

4 – *Collect context information*: Once the data analysis achieved, the indicators feed the design context and the adaptation rules could be fired.

5 – *Adapt the solution*: The system proposes possible adaptations to the designer, according to the fired rules set. Adaptations could lead to provide some recommendations on the design method, or to propose patterns related to the user's action, or to suggest an evolution of the editor configuration, better suited for the design context. The user has always the adaptation under control with the possibility given to modify himself his profile.

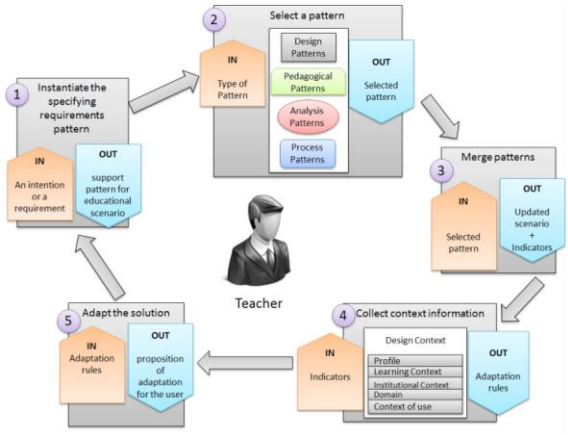

Figure 2: The design process

The pattern representing situations of learning are not directly operational on platforms. To implement the pattern, as it is illustrated by Figure 3, one needs to bind the information of patterns with the concept used in platforms. This binding can be realized with one or some model-to-model transformation if a meta-model of the target platform exists, as our team has proposed [15].

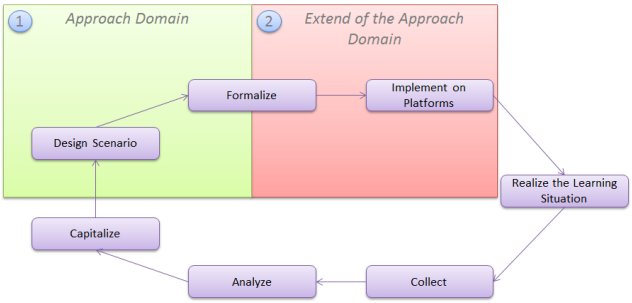

Figure 3: Cycle of a pedagogical scenario

1 – The part of the cycle concerned by our pattern based approach.

2 – The implementation activities in continuity of our approach.

The cycle continues with the realization (using) of the scenario. Data are collected from this realization and are transformed into tracks. Tracks are then analyzed and the information of this analysis is capitalized to be used in one future design.

4. CASE OF STUDY

TPWorks is a learning platform for lab session in automation training introduced in French technological engineering cursus. TPWorks facilitates the sharing of documents and digital resources.

Every lab session has to be well defined and planned in terms of chapters, sub-chapters ordered according to the teacher's intention and motivation. Activities and resources associated have to be defined too (texts, media, and so on).

Observation requirements are also defined in this preliminary step in order to model indicators in relation with each facet of the design context. These indicators are added to existing indicators and implemented with UTL (with the assistance of a computer specialist).

Once logged, the tool editor adapts the set of patterns to the user's design context and configures parameters of the tool according to its profile.

Rooted in this context, we relate here the instantiation of some iterations of the teachers's design process.

First iteration of the design process

Step 1	The teacher defines the name of the session as "Dynamic behavior of a mechanical charge". Lab session content is composed of the following sections: • A short presentation of the system the students will use. • An explanation of the technical problems they may deal with. • A list of the different tasks to be realized. • Additional activities to extent the learning. • Digital resources for the lab work. The teacher has to book the classroom, the electronical equipment, prepare the classroom, check equipment and define the lab session scenario.
Step 2	The teacher defines his intention – that means the way he wants to create his scenarios. He may build the scenario by defining first the learning objectives, then resources needed, and so on. But here, the teacher has preferred describing first the learning situation. So he selects the design primitive associated to the "learning situation" concept. The editor proposes a list of design patterns related to all types of existing learning situations. The teacher may filter the pattern list with the terms "lab work" and "implement". The resulting list is ordered and highlights, at the top, the proposals related to one of the terms or both. Among these choices, the teacher selects the pattern "Implementation for a lab work".
Step 3	The editor adds the selected pattern to the graphical representation of the solution part (Figure 4-A). The scenario is updated with the selected pattern.
Step 4	Indicators associated to the filters are updated. The concepts used to filter patterns list are added to the domain facet if they were not already among the domain concepts. The facet "Context of use" is updated too.
Step 5	The tool adapts the list of concepts to retrieve patterns lists.

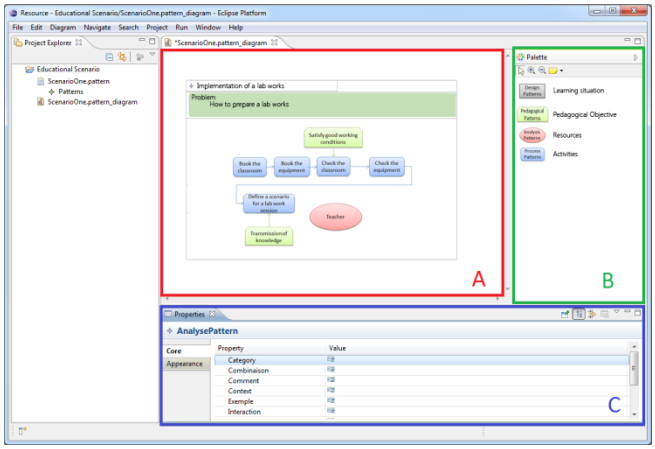

Figure 4: The design tool editor of learning scenario

The pattern "Implementation for a lab work" is composed of a problem and activities. The teacher only needs to modify the solution to apply it to its learning situation.

Second iteration of the design process

Step 1	Issue of the first iteration is compliant with the teacher requirements and he does not specify new ones.
Step 2	When he selects the primitive “activity” in the graphical part, the editor proposes a list of all existing activities. The activities related to the selected learning situation are in the top of the list. The teacher creates a new activity rather than to select an activity in the set of existing activities.
Step 3	The scenario is updated and this activity is added to the solution.
Step 4	The indicators related to this design activity (add an activity) are updated. The method of the indicator “Concept in the Domain Vocabulary” checks if the concept “TPWorks” is part of the current domain facet and if not the domain facet the concept is updated.
Step 5	The tool proposes to adapt the solution by adding the resource material "Computer with TPWorks ".

Third iteration of the design process

Step 1	The teacher analyzes the solution and refines the list of activities and resources needs.
Step	The teacher needs to define human resources. He
2	adds an analysis pattern to the solution and selects or defines the resources he needs in the resources list. He selects the resource “IT technician”.
Step 3	The scenario is updated with this human resource.
Step 4	The method of the associated indicator identifies this analysis pattern as a new one and adds the resource “IT Technician” in the “Institutional Context” facet.
Step 5	The tool adapts the set of proposed patterns (add ‘’IT Technician” resource) in the list of analysis patterns.

Fourth iteration of the design process

Step 1	The teacher analyzes the solution and refines the list of activities and resources needs.
Step 2	He chooses to create an association between the activities “Implemention of a lab work with TPWorks” and “Define a scenario for a lab work session”.
Step 3	The solution is updated with the new association.
Step 4	The method of indicators associated to the observation needs “Associations between activities” for two patterns checks if this association has been already defined and add it to “Context of use” facet.
Step 5	The tool proposes to the user to define an association between existing patterns in the design context to complete the solution.

Finally, the teacher adds the learning objectives selected in a list to complete the solution. He changes the property field "Participant" in order to add the number of expected students (cf Figure 5).

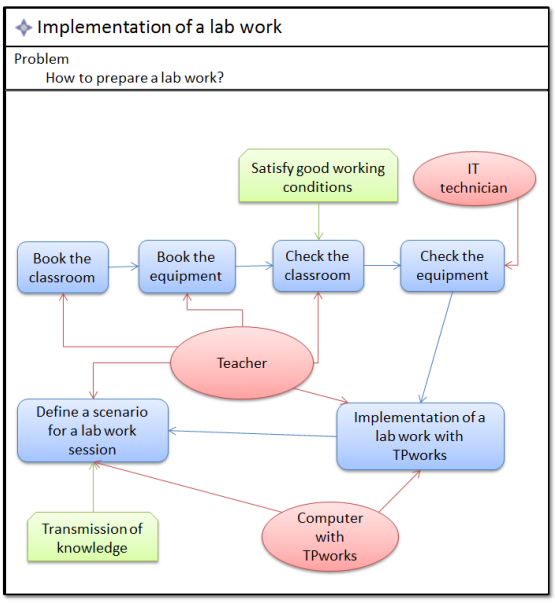

Figure 5: Design Pattern "Implementation of a lab work session with TPWorks"

For deploying on TPWorks the resulting design, the teacher has finally to detail the activity "Define a scenario for a lab work session" with some sub-activities (as "short presentation", "technical problems", and so on). These activities will be implemented as Web pages in TPWorks. The link between the activities and the web pages can be seen as a transformation rule with a transformation Model-to-Model, even if we have not yet implemented this feature.

5. CONCLUSION AND FUTURE WORKS

The evolution of the educational context and technologies requires the teachers to be able to adapt their practices. They have to explicit and to formalize their practices as well as to acquire designer's competencies. We propose in this paper an adaptive user-centered pattern-based learning design approach to help teachers in their learning design activity. An editing tool is proposed to support this approach. This tool is generated into the EMF-GMF framework from a given meta-model of patterns. The tool could be adapted to the user's characteristics (user's profile, user's activities…) and allows the teacher to design a learning scenario by using a domain-specific visual language (expressing patterns in the teacher's business language). This approach is part of an engineering process which includes in particular an implementation process based, for example, on a binding with the meta-model of the targeted LMS. We do not have yet tested our research proposition with teachers but, by developing the tool presented here, we have made the demonstration of its technical feasibility. Further works will be focused on the refinement of the adaptation process.

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