

An Analysis Process for Identifying and Formalizing LMS Instructional Language

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Abstract: Today, the LMS systems require some reengineering works or some additional design approaches because their uses have revealed many difficulties. The teachers-designers meet some obstacles when designing their learning scenarios. In this paper, we propose an LMS centered instructional design approach. This approach is based on the specific instructional language of the LMS system. It focuses on an original process for the identification and the formalization of the instructional language of LMS systems. This process takes into account two complementary viewpoints: the user-centered viewpoint based on the Human Machine Interfaces (HMI) analysis and the techno-centered viewpoint primarily based on the database analysis. We illustrate this process by an example of experimentation conducted on Moodle platform.

1 INTRODUCTION

During the last decade, the Learning Management Systems (LMS) are frequently used for e-learning. LMSs are considered as pedagogical environments allowing teachers to design learners-centered courses and activities. However, many teachers-designers have difficulties (Martinez-Ortiz et al. 2009) while using LMS for learning design purposes, owing to the paradigm the platform embeds. Today, many research works are proposed in order to facilitate the instructional design. These works focus on several EMLs (Educational Modeling Languages) (as PALO (Rodríguez-Artacho and Verdejo Maíllo, 2004), etc.), standards (as IMS-LD (De Vries et al., 2006), etc.), approaches (as Design Pattern approach (Baggetun et al., 2004)), tools and infrastructure (as e-LD (Martinez-Ortiz et al., 2009), etc.)

When analysing these works, we have noted many lacks. Most of these works do not fit with the instructional design difficulties excepting some of them as LAMS which partially satisfies them with its user-friendly interface. Nevertheless, LAMS does not focus on the specific instructional design language (activities, resources, services, etc.) provided by the platform. Others works are often not compatible with LMS. They not ensure the full

operationalization of the models produced outside LMS. They deal with transcription of learning scenarios which highlighted the semantic learning design gap and the loss of information when binding the source scenario on the platform language (Abdallah et al., 2008). These approaches don't take into account the specific learning design in platforms. Sometimes, they required a specific engine or infrastructure dedicated to such LMS in order to implement, execute and play scenarios.

In order to overcome these gaps, we aim to propose an LMS-centered instructional design approach. It aims (1) to facilitate the instructional design and (2) to ensure the specification of models in conformance with the instructional design languages of LMS. In order to take into account this specific language, we propose a specific process aiming to guide its identification and its formalization. This process can be used for many purposes (the specification of new design tools conformed to LMS languages, the development of transformation tools between EML and LMS, the comparison between different LMS languages, etc.). We are practically interested in its use for the specification of learning scenarios out of the LMS space. We think that the instructional design can be easier when providing teachers-designers some graphical tools more adapted to their practices. These tools have to be conformed to the specific

instructional design language of LMS. Following this approach, we guaranteed the full operationalization of the produced models which can be done by specific facilities supporting this specific language.

2 LMS-CENTERED INSTRUCTIONAL DESIGN

2.1 Overview of Our Approach

Although the various approaches (centered on designer's practices, pedagogical patterns, EML, standards, etc.) supporting the instructional design, teacher-designers encounter many difficulties when using platforms for designing or implementing their courses. They have to manage the various platform interfaces. Many parameters of the form-based interfaces have to be adjusted. These parameters are sometimes optional but often too technical at a very low level without any interest in learning design. Our aim is to overcome the difficulties of design for an LMS and go farther the low level of the LMS interfaces. We propose an LMS centered instructional design approach aiming to provide teacher-designer user friendly design tools. Our hypothesis is that each LMS is not pedagogically neutral. It embeds an implicit language based on the LMS specific paradigm to specify the design of a learning activity. Thus, our proposal is based on the following idea: the LMS instructional design language can be identified and explicitly formalized in a computer-readable format.

This language (as well as its meta-model) can be the basis to provide practitioners with some LMS-centered VIDLs (Visual Instructional Design Language) and their external learning design editors. They can facilitate thinking and communication for practitioners (human interpretable formalism).

For developing VIDLs and their dedicated editors, we propose to adopt an MDE (Model Driven Engineering) and DSM (Domain-Specific Modeling) approach (Laforcade 2010). We consider that scenario can be conformed to platform language when is expressed with a Domain Specific Modeling Languages (DSML). The DSMLs are composed by abstract and concrete syntaxes. The identified instructional design language of LMS formalizes the abstract syntax. It also represents the domain model of these DSMLs. Concerning the concrete syntax, these DSML have to be propose a specific notation to represent the language vocabulary in a graphical format.

The VIDLs have to manage the persistence of produced learning scenarios on top of LMS language in the machine-readable format of the considered LMS (binding). The second objective of our work concerns the operationalization of learning scenarios produced by the means of these VIDLs. In our general approach, we propose to add LMS with new communication facilities which deal with the import scenarios specified by specific DSMLs. At same time, these facilities allow the export of the existent courses on platform into an external file. We have chosen to serialize this file in conformance with the format (meta-model, XML schema, etc.) of the identified instructional design language.

2.2 Overview of the Analysis Process

For defining such a language, we propose an original LMS-centered process. This process could interest many communities of practice as the pedagogical engineers and the developers-designers of an LMS-community. Teachers-designers will be the user of our work results (design tools, import/export API, etc.). At first, we have conducted many studies and experimentations from a teacher designer viewpoint on several platforms and LMS systems (Moodle, Ganesha, etc.). Each LMS has its specific paradigm and instructional design language. These differences are not an obstacle to analyze these systems. It allows us to propose a common analysis process. Then, the analysis work focused on two viewpoints. The user-viewpoint is centered on the HMI (Human Machine Interface) according to two strategies: the analysis of an existent course and the analysis of the creation of new courses. The techno-viewpoint is centered on the technical methods.

The analysis process is composed by three main parts (figure 1): the user-centered analysis, the techno-centered analysis and the confrontation and formalization. The first one is centered on the HMI analysis. Performed with a top-down approach, it is conducted by three sub sequential analyses (macro-HMI, functional and micro-HMI). Each analysis has its specific features and provides its own model(s) and formalism(s). The composition activity consists in specifying the main model of the user centered analysis. The second step concerns the techno-centered analysis. Several analysis methods could be adopted (data-bases, source code, course backup, etc.). In this step, we are specifically focused on the database analysis. Finally, the confrontation between the user-centered and the techno-centered models aims to specify the abstract syntax (or meta-model) of the instructional design language for the

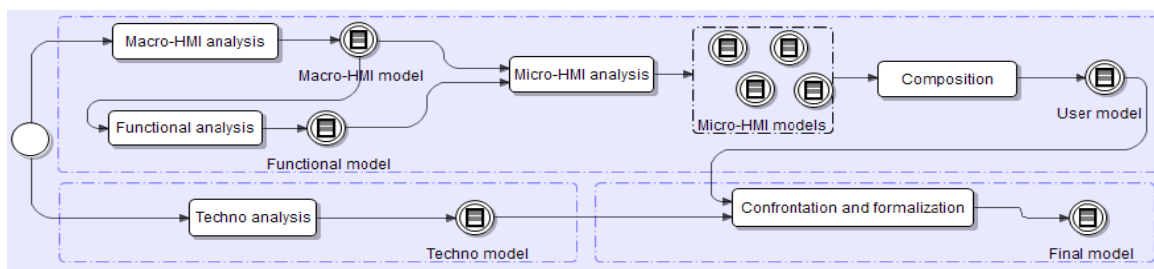


Figure 1: Analysis process of the instructional design language.

considered LMS. This meta-model can be used as the basis for the specification of new LMS-centered VIDL and their dedicated editors.

The user centered analysis ensures the identification of the ‘user-visible’ part of the LMS language provided for users. The techno-centered analysis ensures that models can be specified in conformed format with the LMS language and thus supported by the LMS system. At last, the confrontation between their models ensures the refinement of the user centered analysis and the detection of such lacks.

2.3 Overview of the Experimentation Example

In this paper, we illustrate the process activities by the means of extracts of our global Moodle experimentation. Moodle is a distance learning platform providing a learning environment to create courses, define activities, manage and grade students and so forth. It includes many types of activities (as lessons, forums, quizzes, etc.). The forums and quizzes are highly developed on Moodle. The experimentation is about the identification of the specific instructional design language of the forum activity. A forum is an activity frequently used in courses with Moodle. Its specification requires the setting of many HMI which embeds several pedagogical elements. We will apply the analysis process to identify this specific language.

The model resulting from this analysis is a mapping of the interfaces dedicated to the instructional design. We have chosen to represent each HMI by their main concept in the macro-HMI model. The main HMI concepts are identified by the help of the analysis of the interface titles and sometimes with the analysis of the navigation paths. Often, the adopted ergonomic when designing the interface aims to put the associated titles in relief as well as the titles of the blocks, menus and main parts of an interface. The title often indicates the main concept of the interface or its occurrence. When more than one concept was principal, the analyst can choose one of them. The others concepts will be analyzed in the future analyses (functional and/or micro-HMI). The paths of navigation (if exist) as well as the URLs of interfaces are also an information sources to identify their main concept of interfaces. The relations between concepts are only based on the relations between interfaces.

In the case of the forum experimentation on Moodle, the macro-HMI analysis consisted in identifying their related HMI. The creation of a new forum gives access to new interfaces allowing the specification of new dedicated concepts. We identified HMI for the setting up of discussions. Thus the macro-HMI model (figure 2) is composed by two main concepts: ‘forum’ and ‘discussion’.

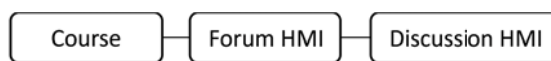


Figure 2: Extract of the macro-HMI model of Moodle forum.

3 USER-CENTERED ANALYSIS

3.1 Macro-HMI Analysis

The macro-HMI analysis consists in identifying the interfaces specifically dedicated to the instructional design. These specific HMI allow teachers to specify the content of their learning scenarios or courses. The HMI are identified both (1) when creating a new course content and (2) when analyzing existing

3.2 Functional Analysis

The functional analysis consists in identifying the functionalities dedicated to the instructional design of course on such LMS. The HMI embed both pedagogical and technical functions. The technical ones (as display functions, etc.) do not concern our work. The functionalities are implicitly embedded in interfaces via HMI widgets (buttons, links, etc.).

Each widget has to be tested in order to determine its pedagogical features. Then, the analyst attributes a function name for each pedagogical widget (as add lesson, respond to questions, etc.).

We have grounded the formalism of the functional model on the SADT (Structured Analysis and Design Technic) Model (Marca and McGowan, 1987). At the same time, we have chosen the UML use cases diagrams (John and Muthig, 2002) for representing the internal sub-functional models. Each identified functionality is represented by the mean of a new use case. Their sub-functionalities are represented into a new use case diagram. Then this diagram is merged into the main use case diagram.

Concerning the forum experimentation on Moodle, the functional analysis has to identify the pedagogical functionalities related to the specification of Moodle forum and its dedicated elements. We identified the “add a forum” functionality by analyzing the main course HMI. Then by analyzing an existent forum, we identified some dedicated sub-functionalities. These ones aim to perform some operations on the discussion element (as add a discussion, answer to discussion, etc.).

3.3 Micro-HMI Analysis

The micro-HMI analysis consists in identifying all elements relevant to the instructional design. Many micro-HMI models describing these elements result from this analysis.

To conduct this analysis, we propose the following approach. After choosing an element of the macro-HMI model, the analysis concerns the interfaces for realising/defining a dedicated use case of the functional model. We have chosen to break down the concerned interface into many areas. For each area of HMI, all elements (components) of it have to be analyzed in order to determine their pedagogical features. The first step is to analyze the titles of blocks, menus, forms, etc. Then, the analysis concerns many pedagogical elements which are described by the use of various forms, widgets and software components (buttons, links, etc.). Two main categories of the forms elements/attributes can be identified: required elements and optional elements. The required ones have to be identified because they form the main elements of the instructional design language of LMS. The non-setting of these elements prevents the ordinary working of system. It is also important to identify the features of these elements in terms of attributes, properties, value fields, default initializations, etc. Some dependencies and relationships between elements are detected when analyzing forms and

conducting some tests. More, the description of relationships requires the definition of multiplicities between their elements. Finally, we noted that the elements ordering is an important feature within the instructional design because it may influence the organization of the course. We have chosen the mind map format to represent the micro-HMI model.

In the case of the forum experimentation on Moodle, the micro-HMI analysis consisted in analyzing at first the form-based interface of forum. This analysis had to identify the specific features of forum (attributes, domains fields, initializations, types, etc.). The same analysis concerned the discussion element in order to identify the dedicated language. The multiplicity between forum and discussion is determined by associating many discussions to forum. We noted that one forum can contain many discussions but each discussion is dedicated to a single forum. This analysis had led to specify two micro-HMI models: forum and discussion models (figure 3 (frame 1 and 2)).

3.4 Composition of the User Model

The composition step aims to formalize the partial instructional design language derived from the user-centered analyses into a single model. It consists in combining the micro-HMI models. The relationships between them are based on their relations into the macro-HMI and the functional models. The composition consists in taking the elements of the macro-HMI model into top-down approach. The relations into the macro-HMI are easily identified but the relations into the functional model are deduced by the help of the following approach. For each element of the macro-HMI model, we have to identify the related part form of the functional model. Many uses cases can reference one or many element(s) which is (are) required for realizing such functionalities. These elements are already identified into the micro-HMI analysis. As well as the functional model, the identified elements are represented in such level. Then the elements for realizing the sub-functionalities are also represented in a lower level and so on. Finally, the multiplicities between models/elements have to be added in the user model. Some of them are already identified during the micro-HMI analysis. At the end, the user model merges whole set of the micro-HMI models using the mind map formalization.

Concerning the forum experimentation on Moodle, the composition consists in associating the ‘forum’ and ‘discussion’ models defined by the micro-HMI analysis (figure 3). Based on the macro

HMI model, as well as the functional model, we deduced discussion is a sub element of forum. We have then specified the multiplicities already identified into the micro-HMI analysis between them.

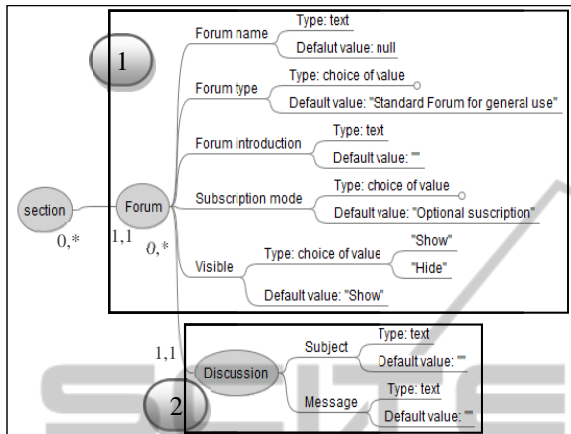


Figure 3: Extract of the user model focusing on the forum design.

4 TECHNO-CENTERED ANALYSIS

During our experimental work we have identified several technical points within an LMS to analyze: data-bases, source code, courses backup/restore (if exist), etc. In this step, the main source of information for identifying the instructional design language is the LMS databases. The other technical analyses would be used during the confrontation step.

The data-bases analysis consists in specifying a reduced Conceptual Data Model from the one available by LMS providers if exists. In our approach, the database analysis has to be restricted to the tables/columns in relation to instructional design data. To conduct this analysis, our methodology consists in (1) looking over all database tables in order to sketch a first draft of the model, (2) focusing on tables embedding elements in relation to instructional design concepts. These tables can be identified through the semantic analysis of their titles or the one of their record fields. Some tables could be identified through their dependencies with others or through the foreign keys. The analysis then consists in specifying the database schema on the basis of the databases reverse engineering rules. The Conceptual Data Model can be finally specified from this schema. In the case of the forum experimentation on Moodle,

we first looked over all the Moodle database tables. We then targeted those related to the forum design through the semantic analysis of their titles (as forum, forum_discussions, forum_posts, etc.). We have then specified the relations between the concerned tables. Finally, we transformed the data base schema dedicated to the instructional design of forums into a conceptual model (figure 4).

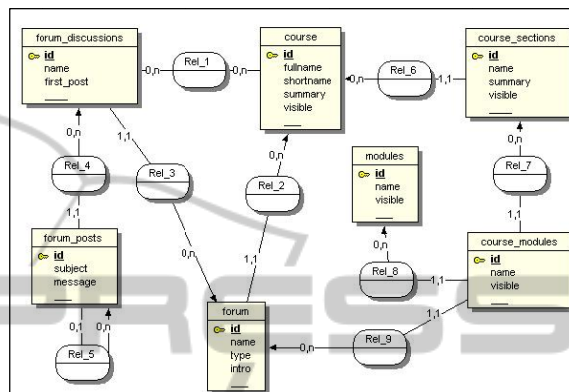


Figure 4: Extract of the techno-model focusing on the forum design.

5 MODELS CONFRONTATION AND FORMALIZATION OF THE FINAL MODEL

The last process step concerns the confrontation of both user and techno models, and the formalization of the final instructional design model. The user and techno models are compared in order to (1) refine the user-model, (2) detect and correct the difference between models, (3) ensure that the final model can be easily bind to a computer-readable format for the existent LMS.

The confrontation conducts verifications on the definition of the instructional design elements on both models. Some differences or ambiguities (like the non-existence of some attributes, divergences about the types of attributes, etc.) are so identified. They require a deeper and finer analysis of both user and techno analysis. At this step, other techno-centered analysis (source code, backup packages, etc.) can be useful.

We have chosen the meta-model formalization because in future use for the specification of VIDLs, and the development of dedicated editors, on top LMS languages in accordance with the DSM (Domain Specific Modeling) approach. These LMS meta-models will also drive the specification of an

equivalent XML schema for the development of the LMS import modules required in our TEL-centered approach for developing future learning scenarios.

For each element of user model, the process checks the existence of this element in the techno-centered model. When the existence of an element is verified, it can be modeled as a meta-class in the meta-model. Then the process verifies the existence and the type of these element attributes. The verified ones are represented as meta-attributes of the parent meta-class element. Finally, the relations between meta-classes must be defined by taking into account the existing relations between elements into the user and techno models. Multiplicities are also verified in each model before its representation on the meta-model. Figure 5 represents the visual part of the meta-model dedicated to the forum sub-part of the Moodle instructional design language.

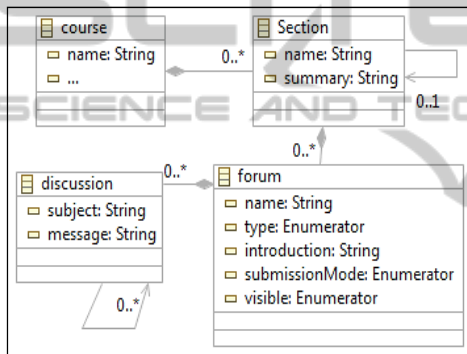


Figure 5: Meta-model extract of the forum instructional design language.

From the meta-model of Moodle instructional design language, we have generated an equivalent XML schema. This schema is used into a communication API we have added to Moodle 2.0 platform. It adds import/export facilities to the course-design content (Abedmouleh et al. 2011). We have also already experiment the use of the meta-model for the development of a very first VIDL, and its dedicated graphical editor, according to the DSM approach (Abedmouleh et al. 2011).

6 CONCLUSIONS

This paper proposes a new LMS-centered approach for instructional design. The aim of this approach is to exceed difficulties of both the design and the implementation of learning scenarios on such LMS. Focused on the potential internal semantics embedded in the targeted LMS, we have presented a

specific process to identify and formalize its specific instructional design language by taking into account the user and techno viewpoints.

This process opens the opportunities to exploit this language for many purposes as (1) the specification of learning scenarios conformed to this language and (2) the generation of new VIDL and dedicated editors on top of this language. The analysis process can be also driven on any others LMS. It can guides comparisons between LMSs. For exploiting the instructional design language, we actually work on the specification of new design tools on top of the meta-model resulting from the analysis process.

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