

A method for identifying and formalizing the underlying instructional design language of existent LMSs

Nour El Mawas, Lahcen Oubahssi and Pierre Laforcade
Université du Maine

LIUM (Laboratoire d'Informatique de l'Université du Maine) Lab
TEL (Technology-Enhanced Learning) Team

Presentation outline

- Context
- Motivation
- The GraphiT project
- Research questions
- Our approach / Moodle case study
- Conclusion & Perspectives

Context

- Learning Management Systems like MOODLE
 - Widespread within academics organizations
 - Not limited to distant courses
 - Provide many tools and services to teachers-designers

But

- They require for teachers
 - to understand the « way of thinking » of LMSs
 - to abstract from technical/low-levels details and form-based screens
- They directly use LMSs depending on their own expertise level
- Instructional design languages and tools are misknown or not at their disposal

Motivation

- Despite
 - many existing standards (Martinez-Ortiz et al., 2009) (Mekpiroona et al., 2008),
 - approaches (De Vries et al., 2006), languages (Baggetun et al., 2004),
 - architectures (Alario-Hoyos et al., 2013), and
 - tools (Baggetun et al., 2004) (Al-Ajan and Zedan, 2007) to facilitate the instructional design,
- they are often not compatible with existent LMSs,
- They require a costly reengineering of the LMS (new web service API, new runtime engines, etc.).
- They do not simplify the operationalization of the produced models. Some translations, leading to information or semantics losses, are still required to operationalize them into a targeted LMS.

The GraphiT project



- **General informations**

- Funded by the french national research agency (ANR)
- Start/End: February 2012 / September 2015
- Website : <http://www-lium.univ-lemans.fr/~laforcad/graphit/>
- Involved several research members from our LIUM laboratory



- **Objective**

- To study how possible it is to specify and develop operationalizable VIDLs/editors starting from the LMS instructional design language and taking into account some practitioners' needs and practices DSM and Model Driven Engineering techniques for VIDLs
- Metamodel composition, model weaving, specification of concrete syntaxes, models transformations Patterns-oriented approaches for making explicit needs and practices
- Pedagogical patterns, analysis & design patterns...

Research questions

- How helping teachers-designers (having an imposed LMS)
 - in improving their capacity of abstraction and understandability of the LMS?
 - in facilitating the design of learning scenarios in conformance to the LMS abilities?
 - In exploiting these scenarios for pre-configuring the courses?

Overview of our approach

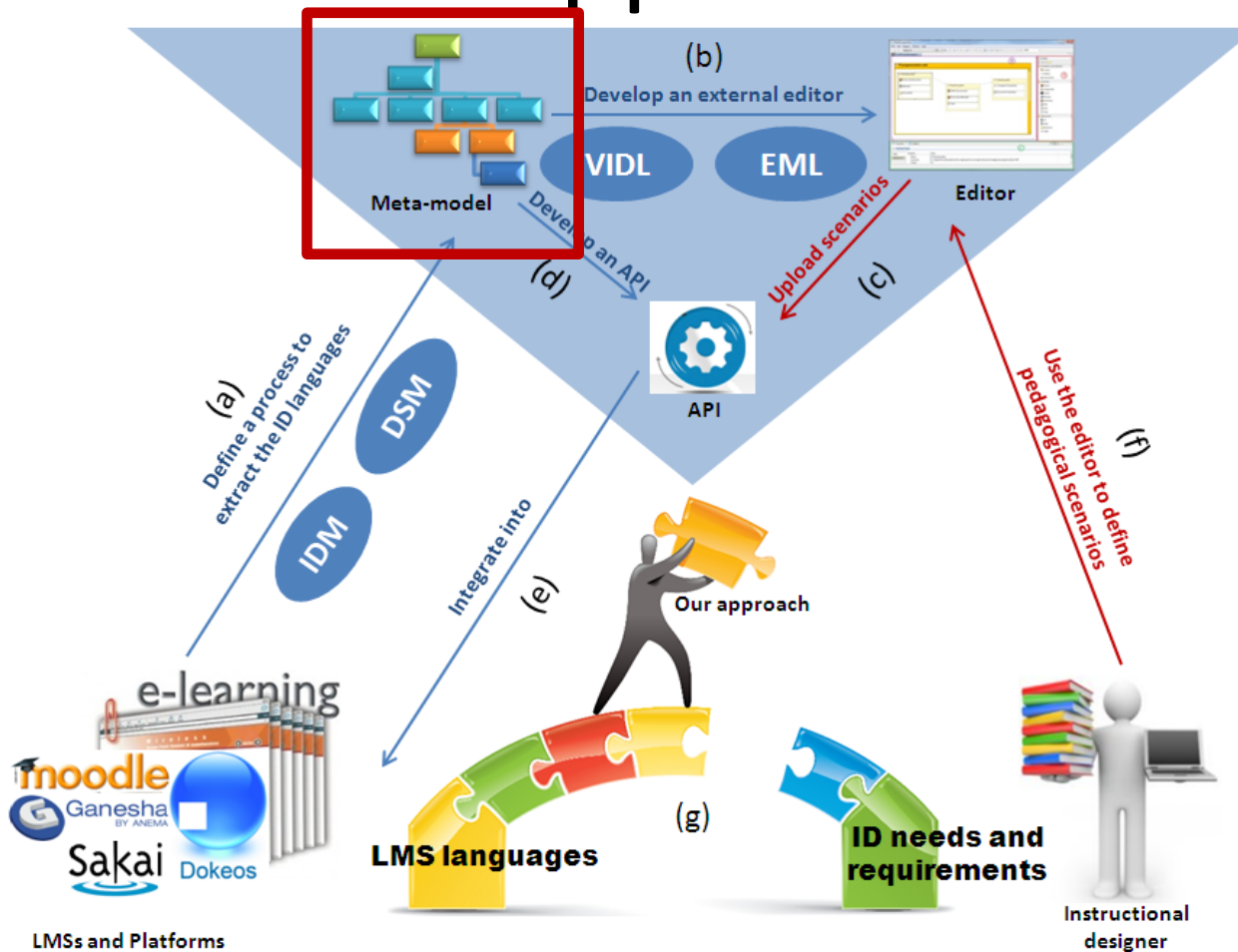
•Hypothesis

- LMSs embed an **implicit** instructional design language
- It is possible to **explicit and exploit** it as a base for **external** design tools

•Added value of our approach

- Specific LMS format (e.g. MOODLE format for quizzes) extended to the whole instructional design aspects
 - without considering the resources => must be included into one XML file
- Analogy with import/export standards (like SCORM)
 - Without having to add a new runtime engine and semantics
 - But an import/export facility (less complex as backup/restore)
- Allow the designing and development of external specific languages and tools in conformance with the one identified
 - For regulation activities, tracking, design of learning situations...
 - For interoperability purposes between two LMSs, etc.

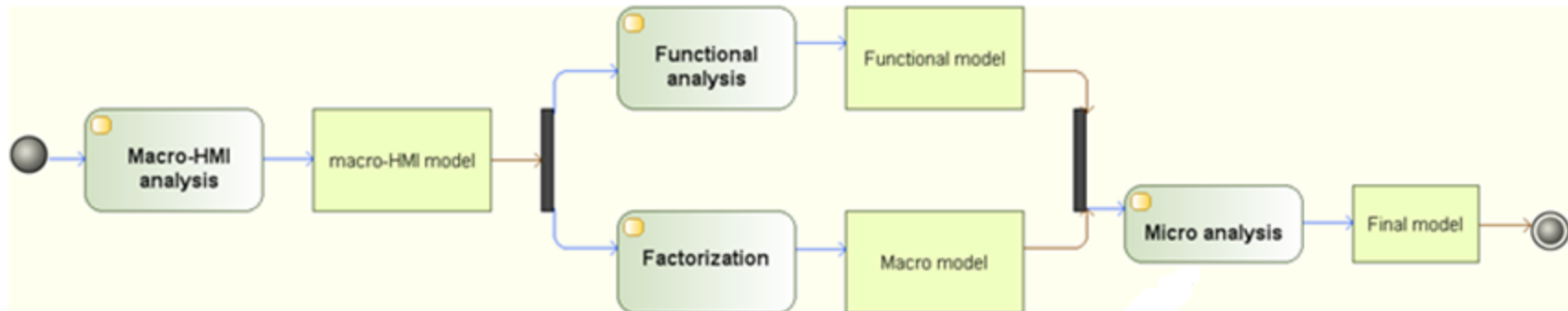
Our approach



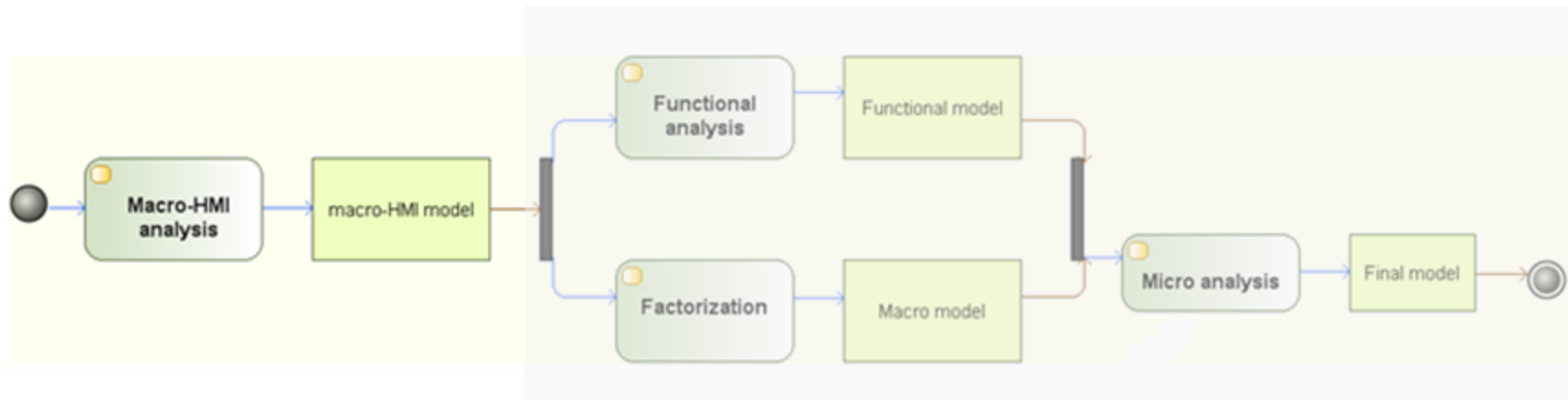
The identification and the formalization process

- We define the necessary analysis and steps for the identification and formalization of an LMS instructional design language.
- It is specified according to three different viewpoints:
 - a viewpoint centred on macro-HMI
 - a functional viewpoint
 - a micro viewpoint.
- Formalism : the meta-model format

The identification and the formalization process : An overview



The macro IHM analysis



Objective : identify platform interfaces related to the Instructional Design (ID).

Moodle macro-HMI analysis

Connecté sous le nom « teacher1 teacher1 » (Déconnexion) Français (fr) [dropdown]

Accueil ► Mes cours ► C1 [Quitter le mode édition]

Course1

Navigation [collapse]

Réglages [collapse]

Administration du cours

- Quitter le mode édition
- Paramètres
- Utilisateurs
- Filtres
- Notes
- Sauvegarde
- Restauration

Aperçu des sections

1

Ajouter une ressource... [dropdown]

Ajouter une activité... [dropdown]

Dossier Atelier

Ajouter Forum [red circle]

Généraux

Nom du forum* [input]

Type de forum [Forum standard]

Introduction au forum* [input]

Police [B I U]

Atelier (par groupe) [red circle]

Phase de mise en place	Phase de remise	Phase d'évaluation	Phase de notation de l'évaluation	Fermé
<ul style="list-style-type: none"> <input checked="" type="checkbox"/> Fournir un texte d'introduction pour l'atelier <input checked="" type="checkbox"/> Fournir des instructions pour la remise des travaux <input type="checkbox"/> Préparer le formulaire d'évaluation 	<p>Attribuer les travaux attendus : 0 remis : 0 à attribuer : 0</p>	<p>Calculer les notes des travaux remis attendus : 0 calculés : 0</p> <p>Calculer les notes des évaluations attendus : 0 calculés : 0</p>		

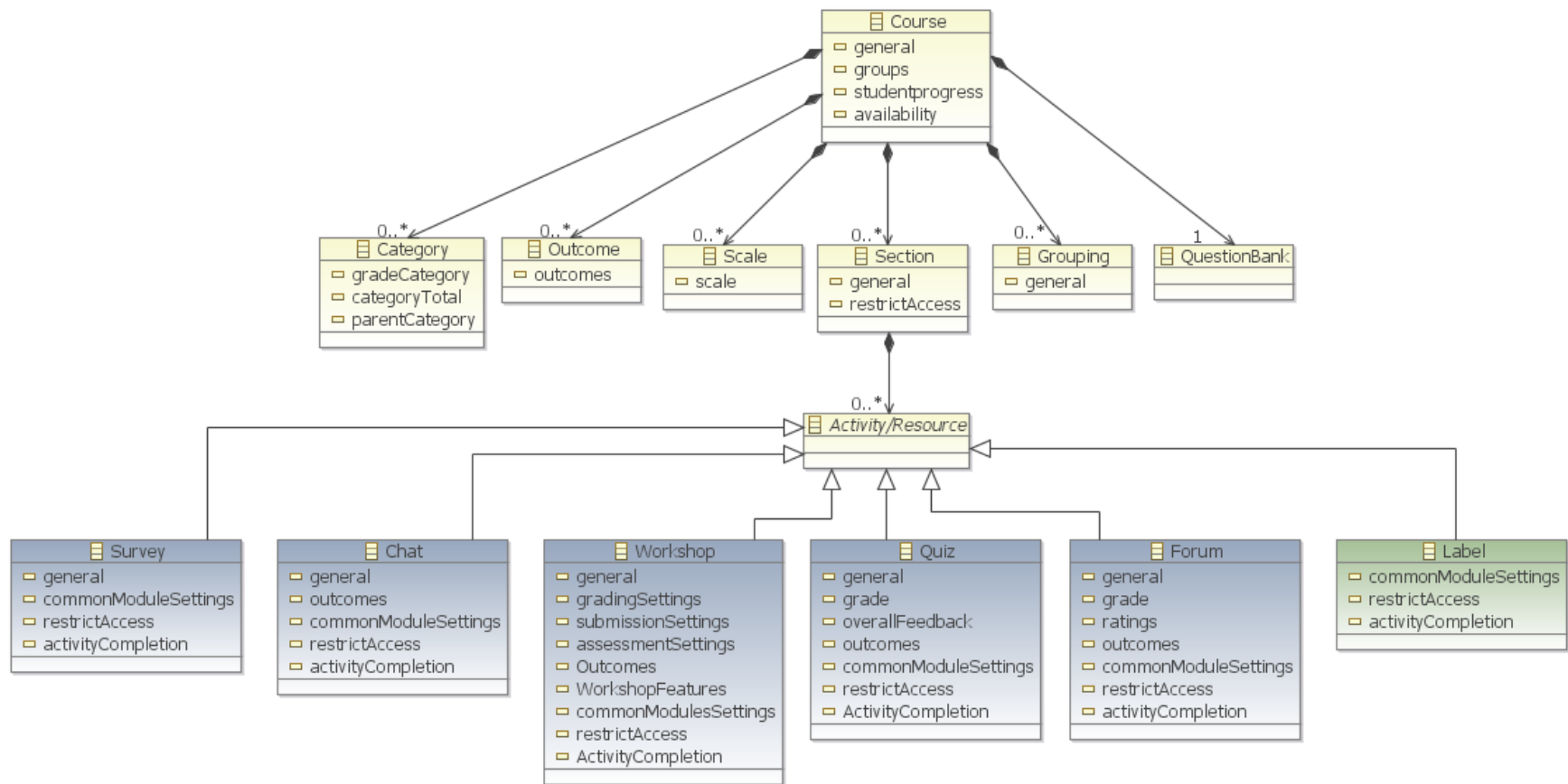
Leçon [red circle]

Preview Edit Reports Grade Essays

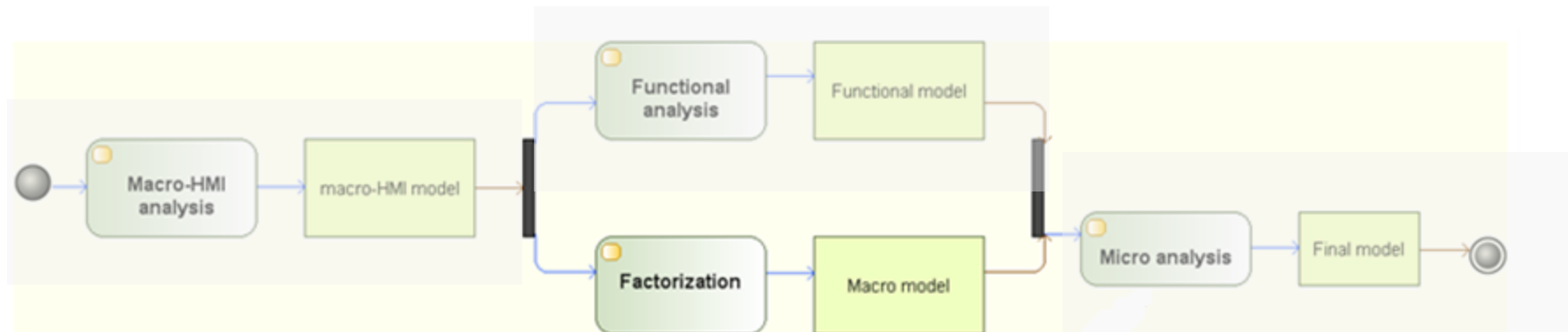
An Unseen question within a cluster jump or an Unseen question content page jump is being used in this lesson. The nextPageContent is used instead. Login as a student to test these jumps.

Mode Abonnement facultatif [dropdown]

An extract of Moodle macro-HMI model



The factorization analysis

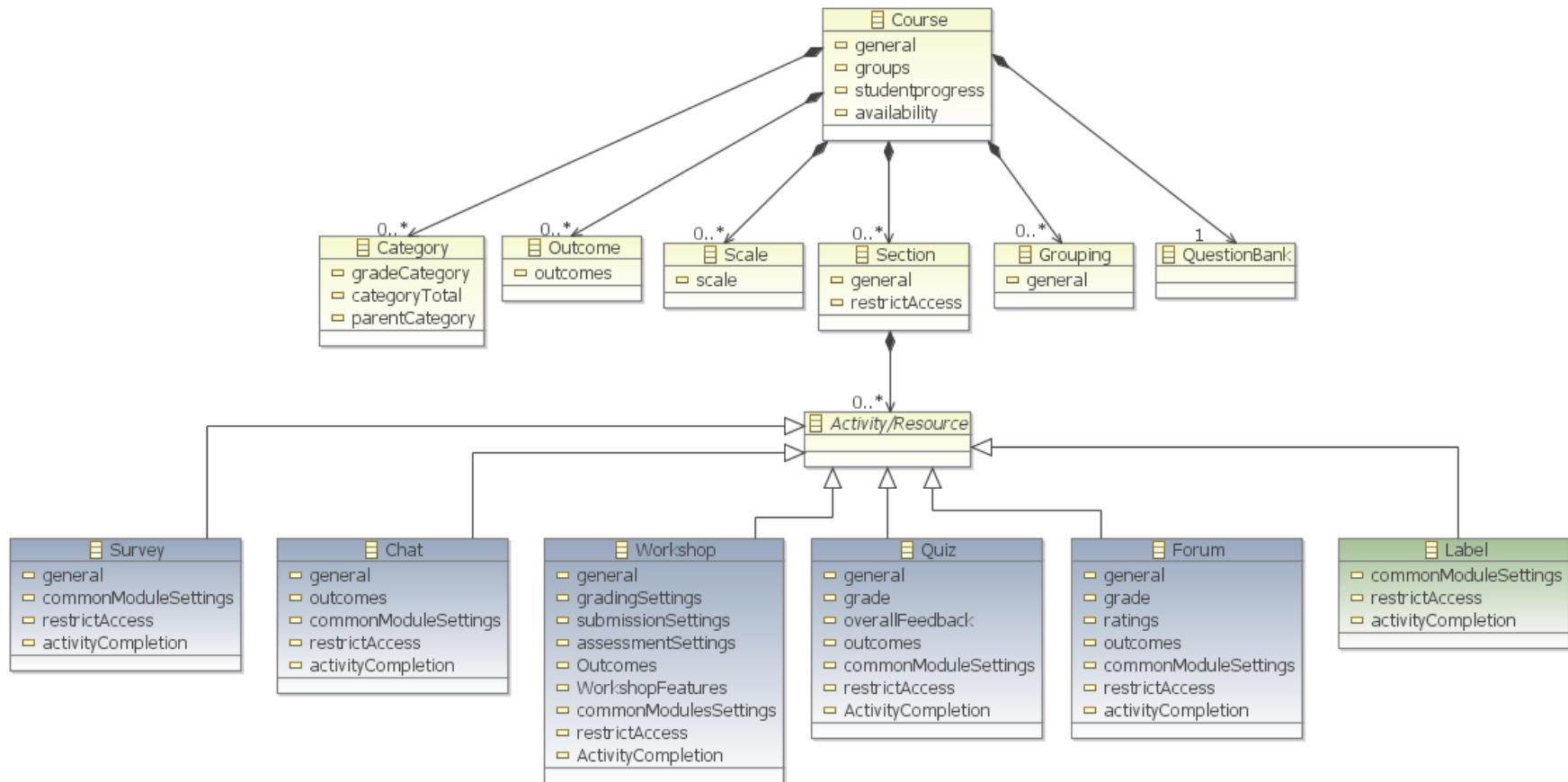


Objective : find common elements in pedagogical activities/resources and common relations between them.

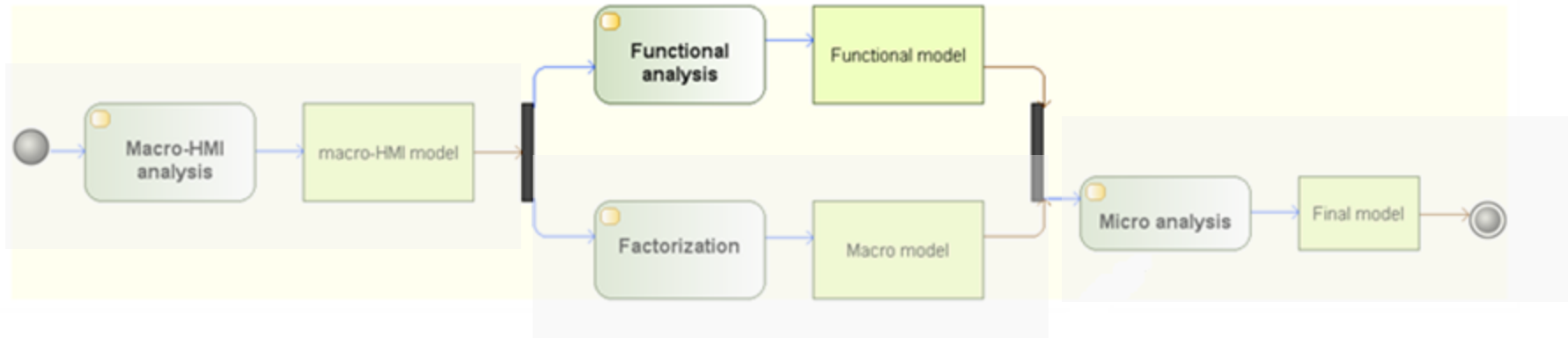
Moodle factorization analysis

- Factorization is the process of finding common attributes shared between two or more pedagogical elements (classes) in the macro-HMI model and moving them into an existent or a new abstract parent element.
- This step aims to find common elements in pedagogical activities/resources and common relations between them. Factorization is applied on the Macro-HMI model. The macro model, resulting for the factorization, is clearer and more simplified than the Macro-HMI model.

An extract of Moodle Moodle Macro model



The functional analysis



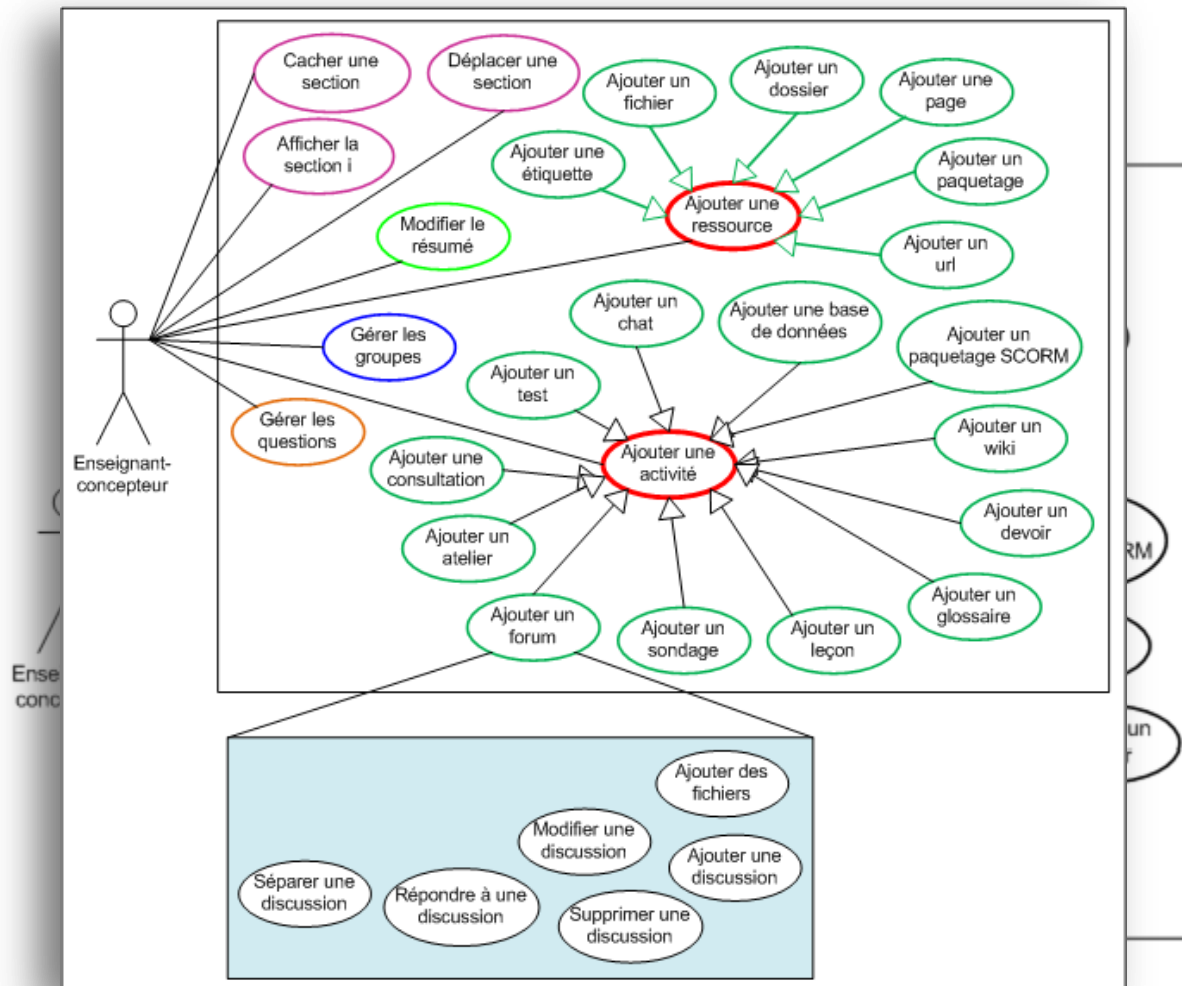
Objective : identify the functionalities dedicated to the course instructional design.

Moodle functional analysis

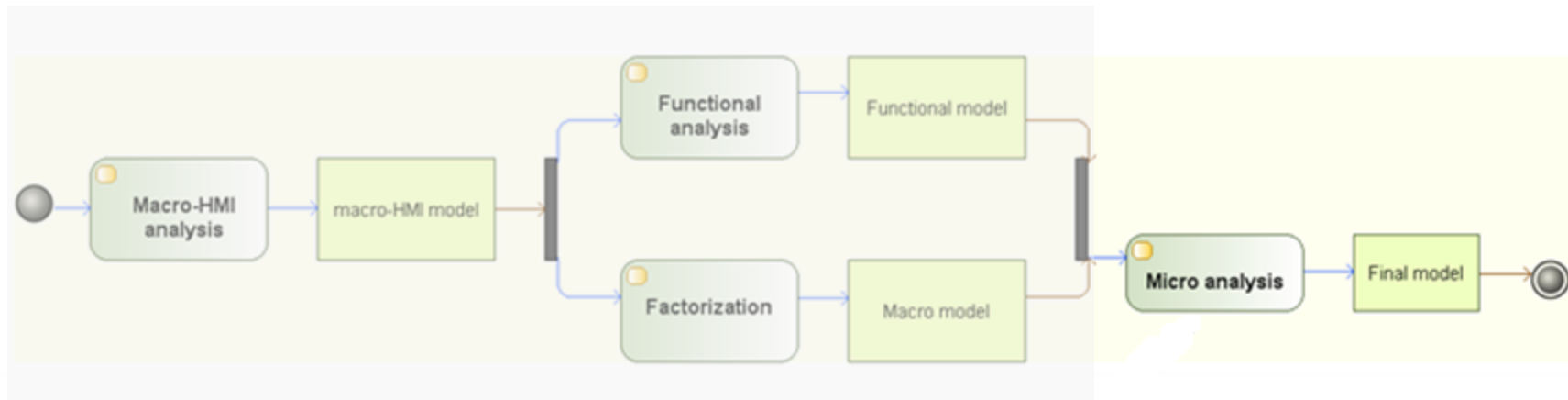
The screenshot shows the Moodle course editor interface for 'Course1'. The interface is annotated with red dashed boxes and numbered callouts (1, 2, 3) highlighting specific functional areas:

- Callout 1:** Points to the top right area containing the user name 'teacher1 teacher1', a language dropdown set to 'Français (fr)', and a 'Quitter le mode édition' button.
- Callout 2:** Points to the left-hand navigation and settings sidebar. The 'Administration du cours' menu is expanded, showing options like 'Utilisateurs', 'Filtres', 'Notes', 'Sauvegarde', 'Restauration', 'Importation', 'Réinitialisation', and 'Banque de questions'.
- Callout 3:** Points to the 'Aperçu des sections' (Section Overview) area. It shows a list of sections (1, 2, 3, 4) with 'Ajouter une ressource...' and 'Ajouter une activité...' dropdown menus. The 'Ajouter une ressource...' menu is open, showing options like 'Dossier', 'Étiquette', 'Fichier', 'Page', 'Paquetage IMS Content', and 'URL'. The 'Ajouter une activité...' menu is also open, showing options like 'Atelier', 'Base de données', 'Chat', 'Consultation', 'Devoirs', 'Forum', 'Glossaire', 'Leçon', 'Paquetage SCORM', 'Sondage', 'Test', and 'Wiki'.

An extract of Moodle functional analysis

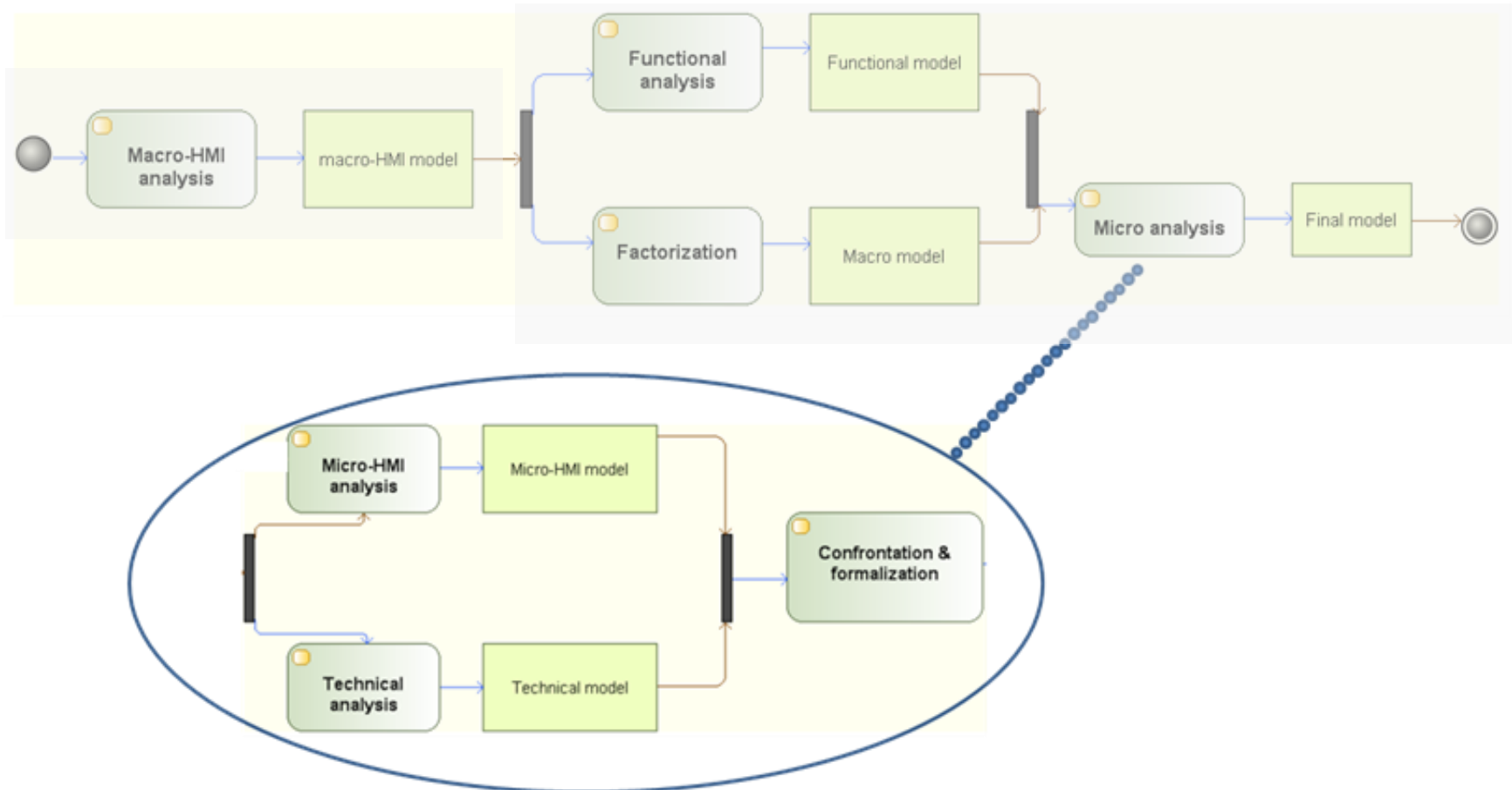


The micro analysis

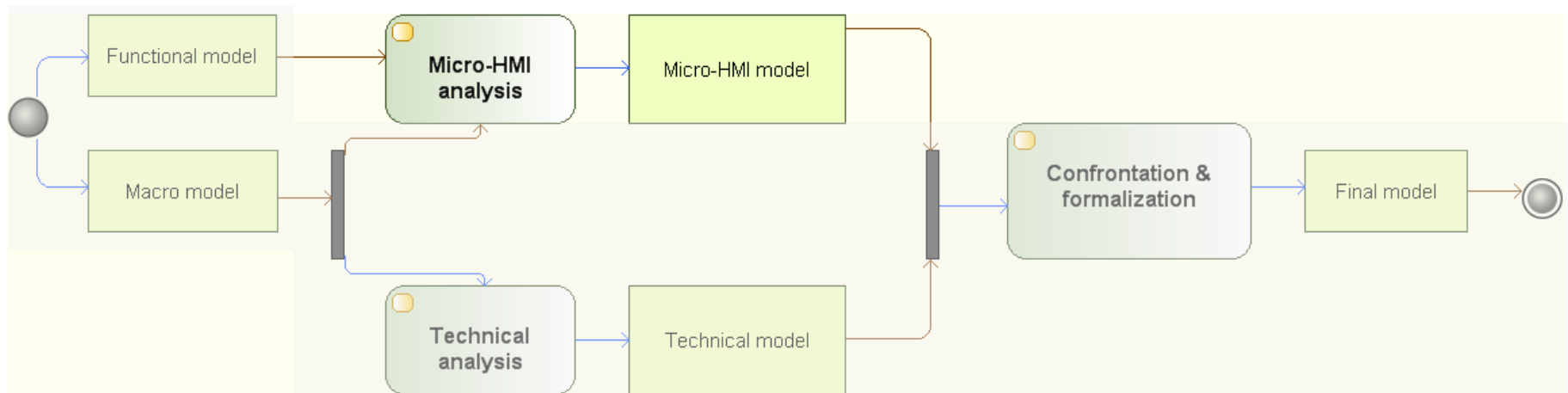


Objective : takes into account two different viewpoints: micro-HMI and technical viewpoints.

The micro analysis



The micro HMI analysis (micro analysis)



Objective : identify all elements relevant to the instructional design, including their features (attributes, types, etc.).

Moodle micro HMI analysis

The screenshot shows the Moodle 'Ajouter Forum' (Add Forum) page. The interface is annotated with three red circles:

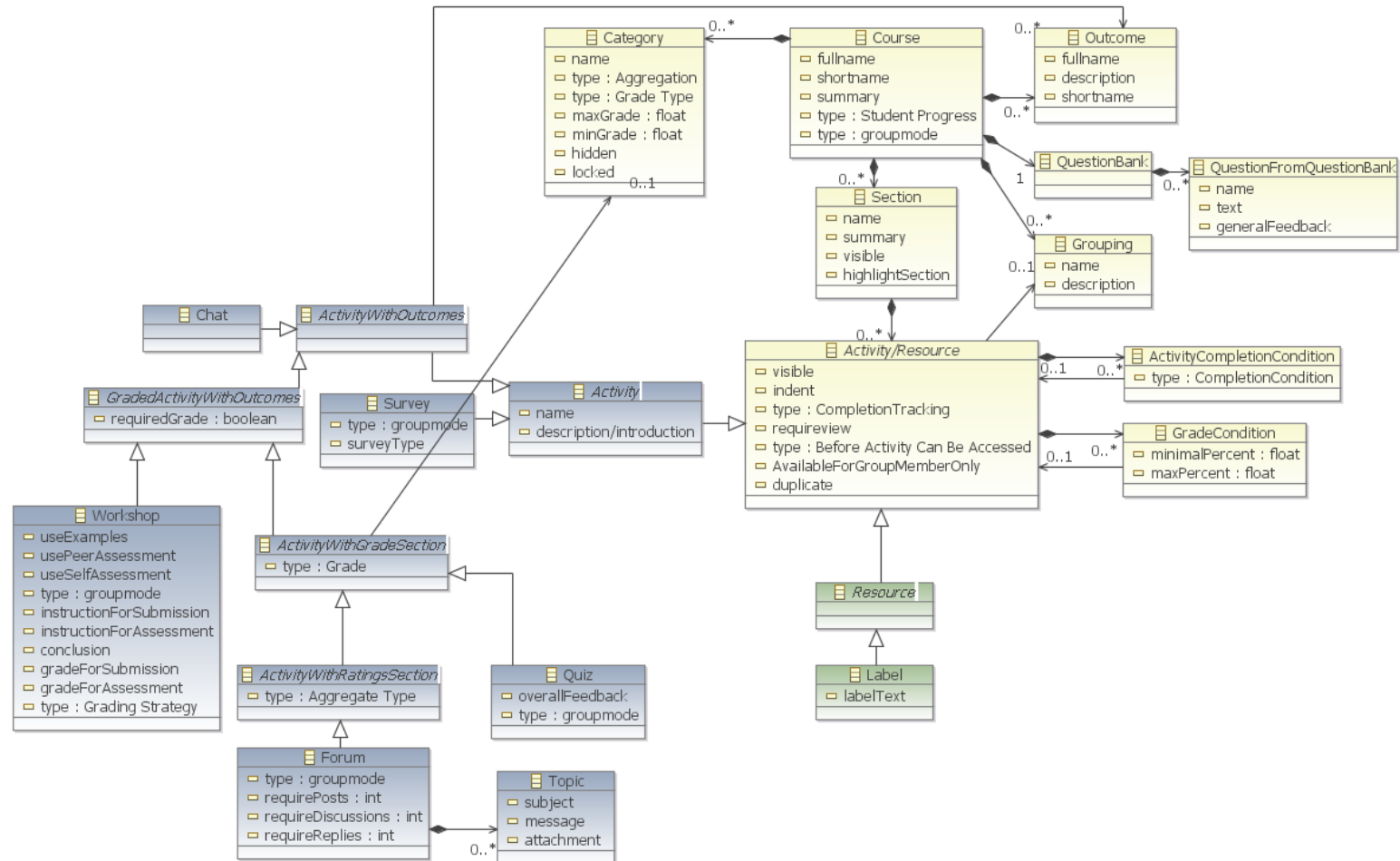
- 1**: Located at the top right of the page, near the user connection status: 'Connecté sous le nom « teacher1 teacher1 » (Déconnexion)'. It points to the user information area.
- 2**: Located in the left sidebar, pointing to the 'Mes cours' (My Courses) menu item, which is expanded to show 'course1'.
- 3**: Located at the top right of the main content area, pointing to the 'Ajouter Forum' title.

The main content area is titled 'Ajouter Forum' and includes a 'Généraux' (General) section with the following fields:

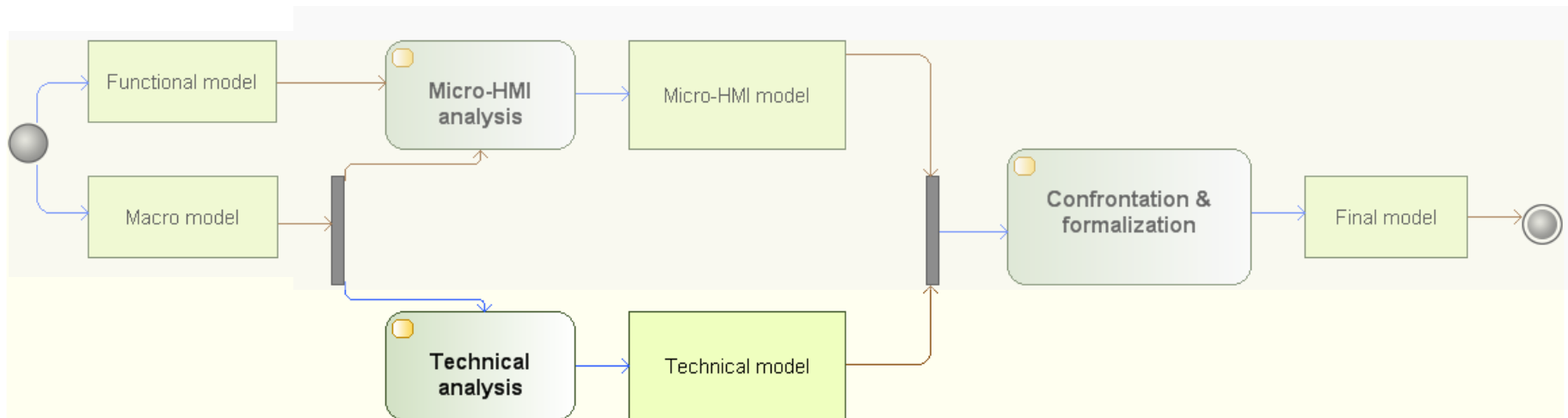
- Nom du forum* (Forum name)
- Type de forum (Forum standard pour utilisation générale)
- Introduction au forum* (Introduction to forum)
- Chemin (Path)
- Format HTML (HTML format)
- Mode d'abonnement (Subscription mode: Abonnement facultatif)
- Suivi des messages lus (Message tracking: Facultatif)

The left sidebar contains a 'Navigation' menu with 'Accueil', 'Ma page', 'Pages du site', 'Mon profil', 'Mes cours' (expanded to 'PW-PHP' and 'course1'), and a 'Réglages' (Settings) menu with various course management options.

An extract of Moodle micro HMI model



The technical analysis (micro analysis)



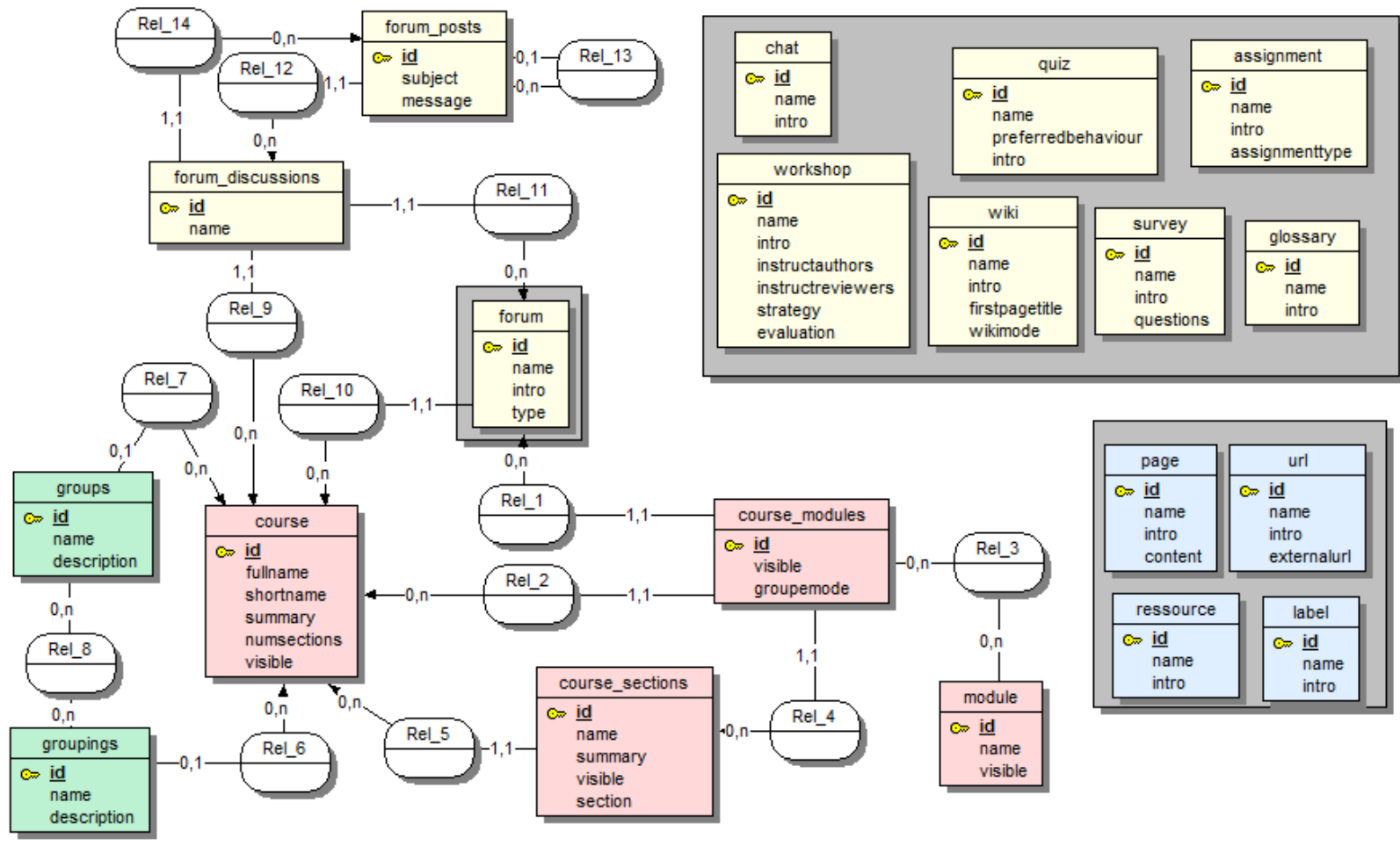
Objective : specify a reduced Conceptual Data Model from the one available by LMS providers if it exists.

Moodle technical analysis

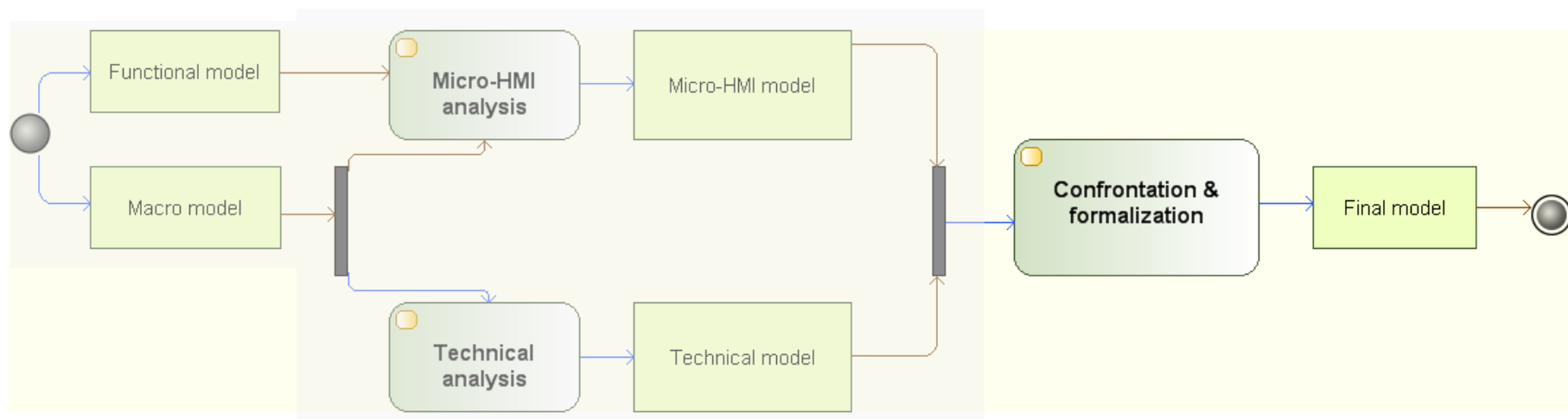
- This technical analysis consists in
 - (1) looking over all database tables in order to sketch a first draft of the model,
 - (2) focusing on tables embedding elements in relation to instructional design concepts.

mdl23_assignment	filter_active	grade_import_values	mdl23_profiling
mdl23_assignment_submissions	filter_config	grade_items	mdl23_question
mdl23_backup_controllers	folder	grade_items_history	mdl23_question_answers
mdl23_backup_courses	forum	grade_letters	mdl23_question_attempts
mdl23_backup_files	forum_discussions	grade_outcomes	mdl23_question_calculated
mdl23_backup_files_template	forum_posts	grade_outcomes_courses	mdl23_question_calculated_options
mdl23_backup_ids	forum_queue	grade_outcomes_history	mdl23_question_categories
mdl23_backup_ids_template	forum_read	grade_settings	mdl23_question_datasets
mdl23_backup_log	forum_subscriptions	groupings	mdl23_question_dataset_definitions
mdl23_backup_logs	forum_track_prefs	groupings_groups	mdl23_question_dataset_items
mdl23_block	glossary	groups	mdl23_question_match
mdl23_block_community	glossary_alias	groups_members	mdl23_question_match_sub
mdl23_block_instances	glossary_categories	imscp	mdl23_question_multianswer
mdl23_block_instance_old	glossary_entries	label	mdl23_question_multichoice
mdl23_block_pinned_old	glossary_entries_categories	lesson	mdl23_question_numerical
mdl23_block_positions	glossary_formats	lesson_answers	mdl23_question_numerical_options
mdl23_block_rss_client	grade_categories	lesson_attempts	mdl23_question_numerical_units
mdl23_block_search_documents	grade_categories_history	lesson_branch	mdl23_question_randomsamatch
mdl23_block_association	grade_grades	lesson_grades	mdl23_question_sessions
mdl23_block_external	grade_grades_history	lesson_high_scores	mdl23_question_shortanswer
mdl23_cache_filters	grade_import_newitem	lesson_pages	mdl23_question_states
mdl23_cache_flags	grade_import_values	lesson_timer	mdl23_question_truefalse

An extract of Moodle technical model



The Confrontation & formalization (micro analysis)



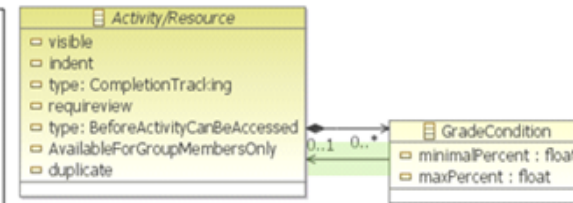
Objective : concerns the confrontation of both micro-HMI and technical models, and the formalization of the final model.

The Confrontation and formalization (micro analysis)

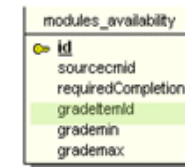
- The micro-HMI and technical models are compared in order to
 - (1) refine the micro-HMI model
 - (2) detect and correct the difference between models
 - (3) ensure that the final model can be easily bind to a computer-readable format for the existent LMS.
- Some differences or ambiguities are so identified. They require a deeper and finer analysis of both HMI and technical analysis. At this step, other technical-centred analysis (source code, backup packages, etc.) can be useful.

The Confrontation and formalization

```
// Check grade
if (!is_null($cm->completiongradeitemnumber)) {
    require_once($CFG->libdir.'/gradelib.php');
    $item = grade_item::fetch(array('courseid'=>$cm->course, 'itemtype'=>'mod',
        'itemmodule'=>$cm->modname, 'iteminstance'=>$cm->instance,
        'itemnumber'=>$cm->completiongradeitemnumber));
    if ($item) {
        // Fetch 'grades' (will be one or none)
        $grades = grade_grade::fetch_users_grades($item, array($userid), false);
        if (empty($grades)) {
            // No grade for user
            return COMPLETION_INCOMPLETE;
        }
        if (count($grades) > 1) {
            $this->internal_systemerror("Unexpected result: multiple grades for
                item '{$item->id}', user '{$userid}'");
        }
        $newstate = self::internal_get_grade_state($item, reset($grades));
        if ($newstate == COMPLETION_INCOMPLETE) {
            return COMPLETION_INCOMPLETE;
        }
    } else {
        $this->internal_systemerror("Cannot find grade item for '{$cm->modname}'
            cm '{$cm->id}' matching number '{$cm->completiongradeitemnumber}'");
    }
}
}
```

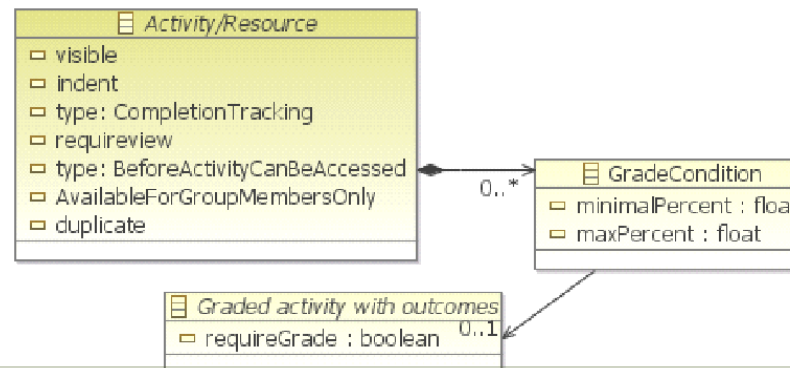


Association relationship between « Activity/Resource » and « GradeCondition » according to the micro-HMI analysis

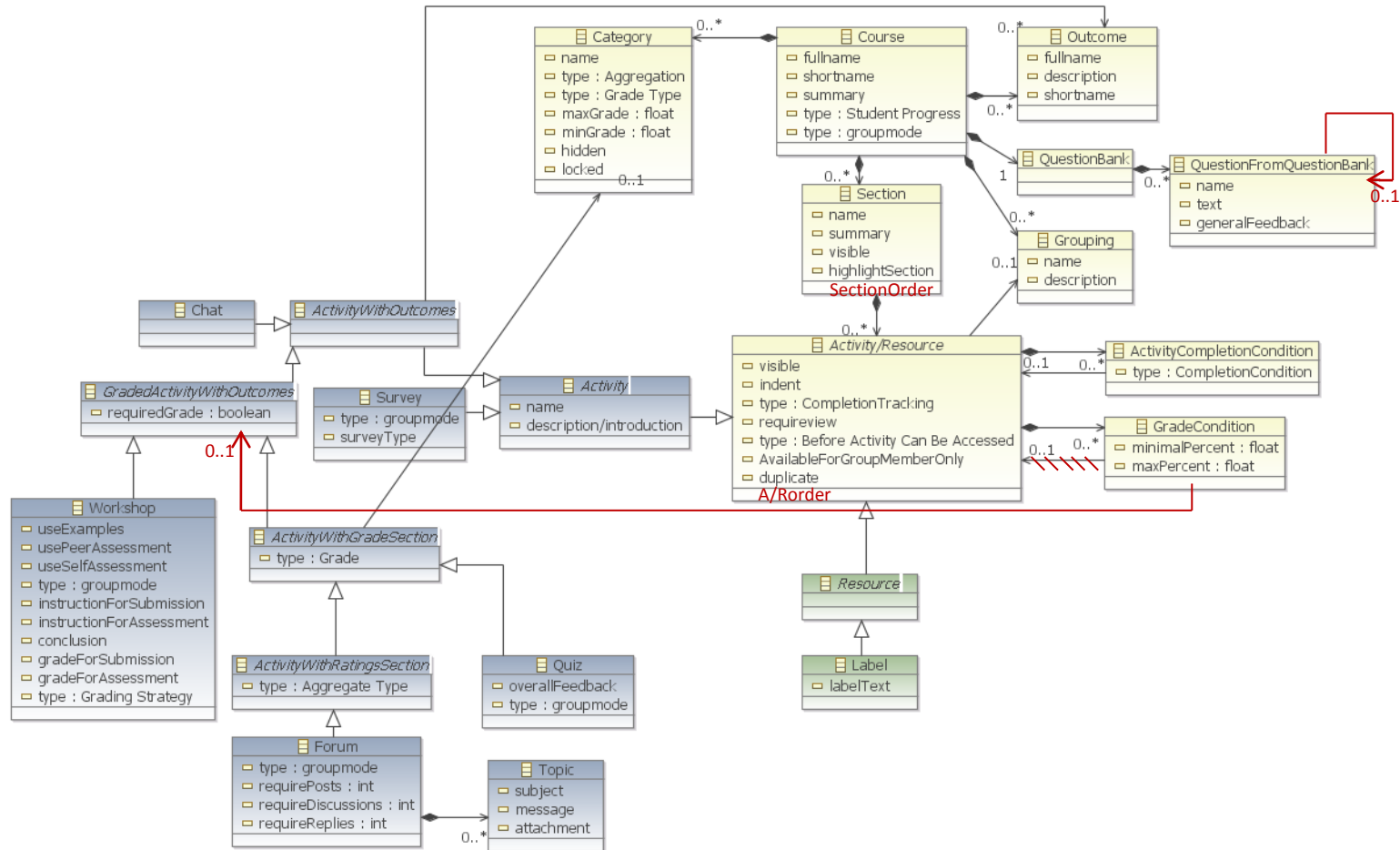


« GradeCondition » according to the technical analysis

Part of the source code moodle/lib/conditionlib.php

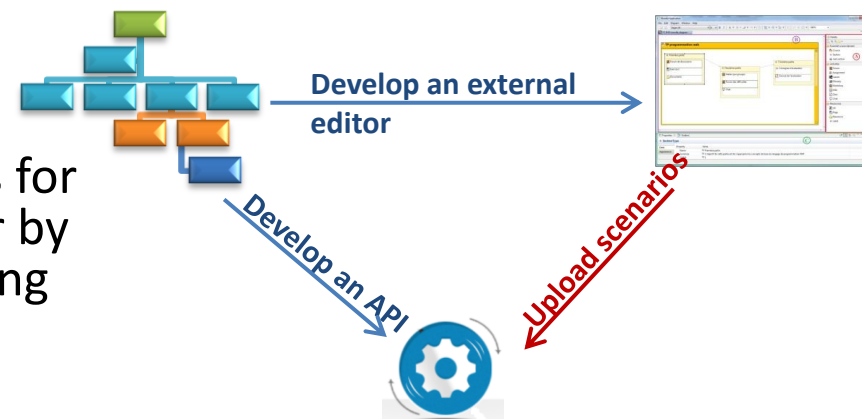


An extract of Moodle final model



Conclusion & Perspectives

- a meta-model-based approach and method for identifying and formalizing LMS languages.
- We apply our proposed method on the Moodle platform
- The meta-model will be used as a basis for the development of the external editor by using a Model Driven Engineering tooling like EMF-GMF.
- This will facilitate the use of LMS and allow to teachers and pedagogical engineers (service information technology and communication for education) of becoming more familiar with the specific design upon this LMS.



A method for identifying and formalizing the underlying instructional design language of existent LMSs

Thank you!

Contact emails:

nour.el_mawas@univ-lemans.fr
lahcen.oubahssi@univ-lemans.fr
pierre.laforcade@univ-lemans.fr