# Modeling and Object-Oriented Design of Adaptive Hypermedia in Distance Learning

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**Abstract**

In this article, we are interested in the modeling and design of an adaptive hypermedia dedicated to distance learning. The architecture of this system is mainly based on three models. The learner model which represents all the user data, the domain model which represents the pedagogic content to teach. Finally, the model of adaptation which permits generating and adapting the pedagogic content to the real needs of the learner.

The experiments in a real context allows us to assess our system and interpret the behaviors of the learners with such learning mode.

***Keywords:*** *Adaptive hypermedia, learner model, domain model, model of adaptation, UML, OOP.*

## 1. Introduction

The architecture of any adaptive system dedicated to learning is mainly composed of a learning model and a domain model [1]. The first one allows taking into account the different characteristics of the user: his information, needs, preferences, objectives, competences, knowledge, etc..[2] These diverse parameters can be acquired by some questionnaires and a survey from the interactions of the learner with the computer system. In accordance with [3], the second model, also known as "the domain of knowledge" or "the model of knowledge", has the objective of determining the pertinent concepts and their relations, and providing a global structure of the field of learning (the or course).

In this article, we will define conceptually the different elements of our system using UML (Unified Modeling Language). We will focus in the beginning on the two sub-models of the learner in the system: the know model and the attitude model [4]. In a second step, we will undertake an analysis of the domain model, we will be interested in the study the characteristics of the elementary fragments which make this model and allow it to build the courses [5].

## 2. Scenario of using our system by the main actors

Firstly, we will describe the scenario of use from the point of view of the learner, the main user of this system. This scenario consists of describing the actions and reactions between the system and the learner.

The system starts by identifying the learner, if it is his first time of use; a questionnaire will be presented [6]. The questionnaire is a set of psychological questions whose goal is to determine the preferences of the learner, his desires, habits, etc…The set of his responses allows the adaptive hypermedia to define the dimensions of the learner's style of learning, which is the main component of the sub-model attitude of the learner[7, 8, 9].

When a learner, who is already registered, chooses a course for the first time, the system will issue him a questionnaire, that is of type knowledge ("to know"). The results of this questionnaire will allow the system to initiate the sub-model knowledge ("to know") of the learner by attributing a level (Beginner, Intermediate or Advanced "Expert"). According to the results of these two tests, the system goes to the assembly of the appropriate course by accessing all the objects which constitute the course, and by determining which ones, among the latters, who should be presented in the adaptive hyperdocument.

The use case diagram for the learner, illustrated in the following figure 1, includes the tasks which the learner can execute in our system.

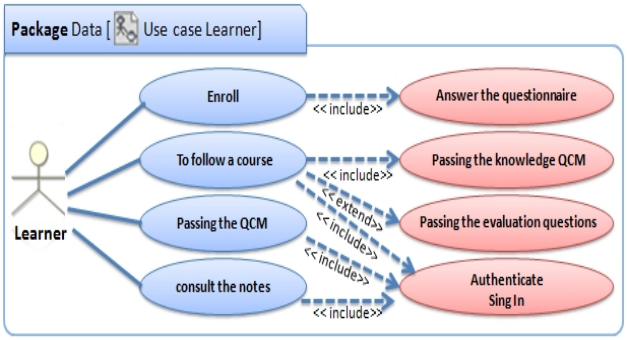


Fig 1: The use case diagram for the Learner

The interaction of the teacher with the system can be summarized as follows:

- ✓ Invite the learners to sign up in the system,
- ✓ Create a course in a field of learning,
- ✓ Create the MCQ related to “knowledge” ("knowledge MCQ" and "evaluation MCQ"),
- ✓ Create lessons plans (default plan and personalized
- ✓ ones)
- ✓ Divide the course into fragments (Picture, Movie, Slides, Java Applet, Flash Animation, Text, Simulation, etc…),
- ✓ Complete every fragment with a pedagogical signature concerning the dimension of the learning style of the learner to whom we can attribute such fragment (Sequential / global; Inductive / Deductive; Active / Pondered; Visual / Verbal), the level of knowledge required for this fragment and eventually the prerequisites and the post-requisites of this fragment; at last, save the content (fragment +pedagogical signature) in the system’s database.

The use case diagram for the teacher is represented in the following Figure 2:

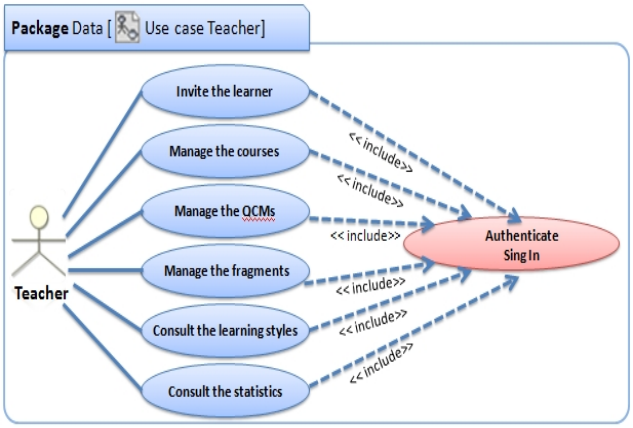


Fig 2: The use case diagram for the Teacher

- ✓ The tasks of the system administrator can be summarized in the following points (see Figure 3):
- ✓ The invitation of the teachers,
- ✓ The management of the fields: create, modify and delete a field of training,
- ✓ Enable or disable a question of Felder for each of the four dimensions of the learning style on the purpose of reducing the number of questions,
- ✓ Consult the learning styles.

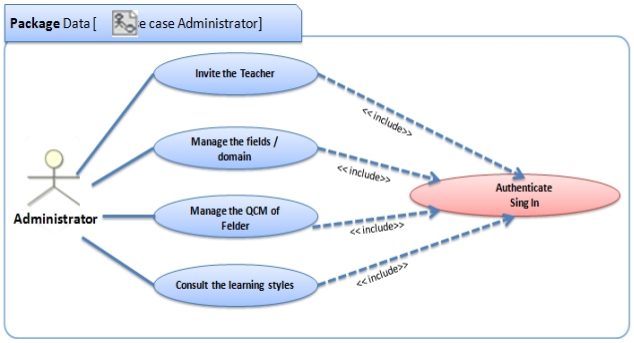


Fig 3: The use case diagram for the Administrator

The following Figure 4 summarizes the interactions of the main actors (Learning and Teaching) with the system.

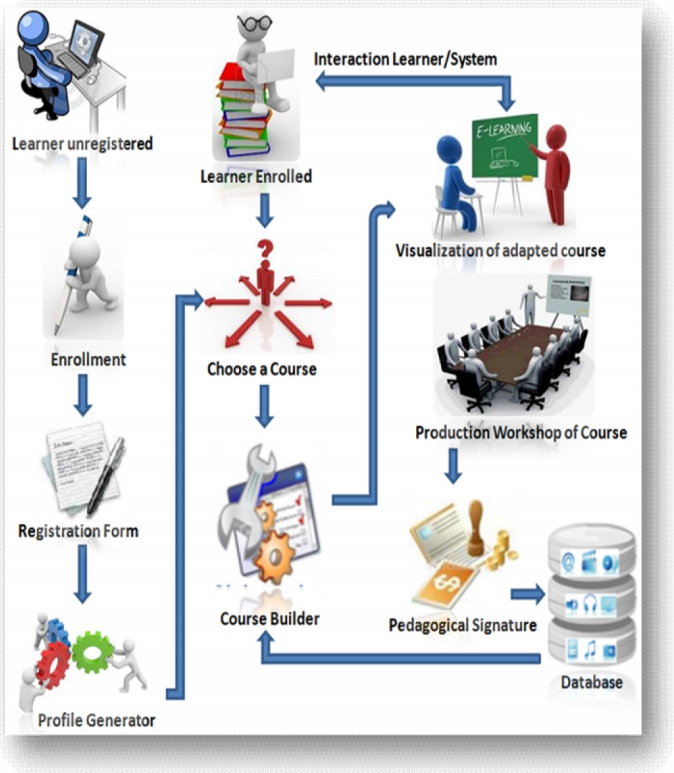


Fig 4: The Interactions of the main actors (Learning and Teacher) with the system

## 3. The Learner Model

The learner model is actually composed of two sub-models, the sub-model of "knowledge" and the sub-model of "attitude", and a library of types. In this section, we will be interested on class diagrams in UML modeling these different components of this model.

### 3.1 Sub-model of "knowledge"

We have grouped the content of this sub-model in a package named "modelesavoir". This package is represented in the following Figure 5:

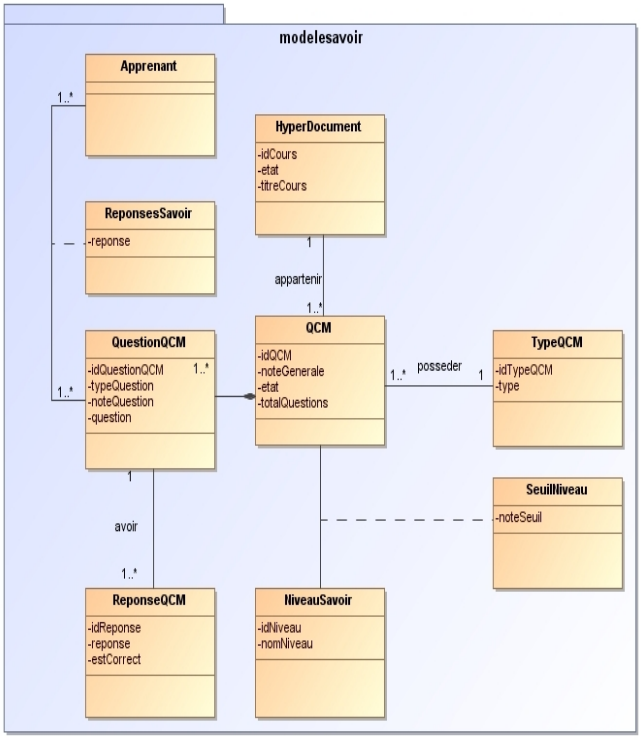


Fig 5: The class diagram of the sub-model "knowledge".

Our sub-model "knowledge" is of a partial expertise type, that is to say, while associating a weighting to every course of the domain model. This value is relevant to a date, in order to take account of the phenomenon of forgotten thanks to "evaluation MCQ".
Before starting the session corresponding to the course learning, the learner must take a " knowledge MCQ" to initialize the sub-model "knowledge" of the learner by attributing a level (Beginner, Intermediate or Advanced "Expert")

### 3.2 Sub-model of "attitude"

The second sub-model "attitude" of learner will allow to choose the general structure of the course adapted to the learner profile and to put in form his content. This component will attribute a cognitive type and a learning style to a learner.
At the beginning of his first use of hypermedia, when registering on the system, the learner must answer a questionnaire which allows him to be classified into a stereotype, according to the values of the four dimensions of learning style, this stereotype associated with the sub-model of "knowledge" determines the course plan that will be used and previously defined by the teacher, A big part of this process will be treated dynamically at the time of the software development of our system.
The historic of learner's activities will be saved for eventual use by the system, and allow the learner to retake the questionnaire for an updating of the sub-model "attitude".
We have grouped the content of this sub-model in a package named " **modeleattitudeapprenant** ". This package is represented in the following Figure 6:

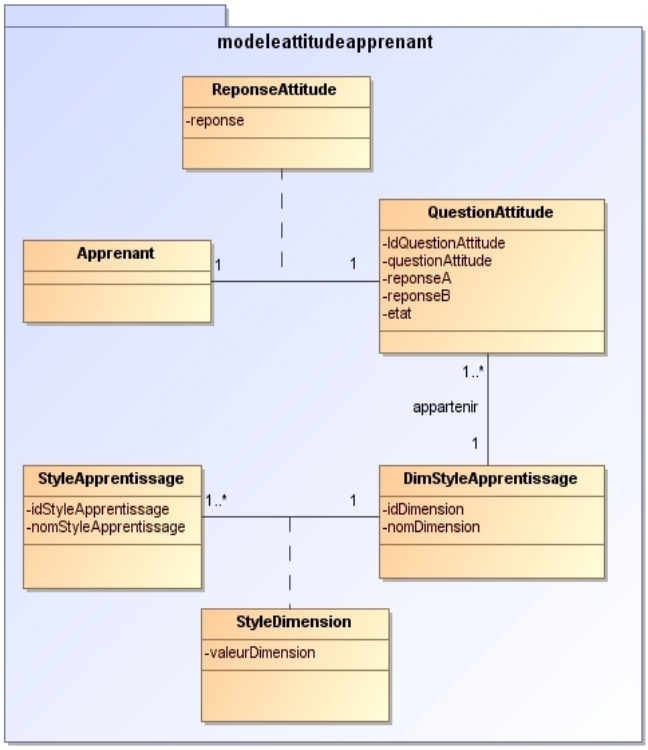


Fig 6: The class diagram of the sub-model " attitude".

## 4. The Domain model:

The following Figure 7, allows detailing the different components of our domain model. The hyperdocument (the course) is composed of one or several fragments, the attributes of a hyperdocument are identifying it, the

document title and the course status (Enabled or Disabled). To every course and for every learning style is associated with a custom plan, otherwise a default plan is applied. The plan is constituted of several entries that represent the titles of paragraphs which compose the course.
The fragment is composed of a media or more; These media can be text type, audio, Movie, animation, picture, slide, PDF file, simulation, or other types. A fragment attributes are: the ID, a description, the link of the resource and the status (Enabled or Disabled). The teacher must associate a level (beginner, intermediate or Expert) for each fragment, characterize it by a set of metadata and choose in which entries it will be appear according to predefined plans.
The following class diagram clearly explains our approach to the conception of the domain model of our adaptive hypermedia. The package of this model is named "**modeledomaine**."

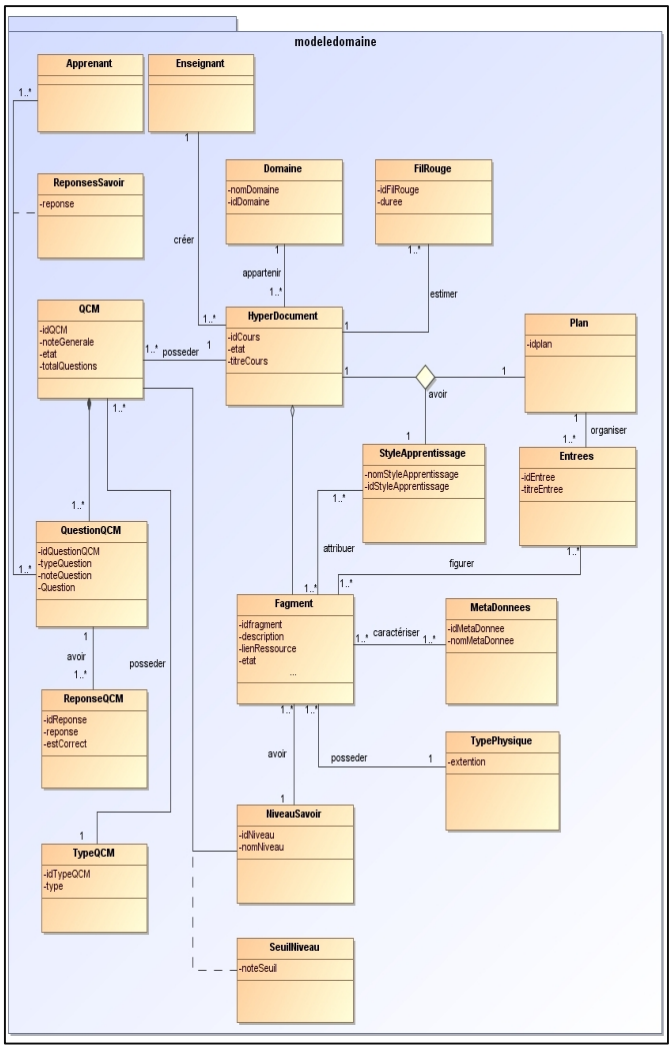


Fig 6: The class diagram of the domain model.

## 5. Course Generator:

The sub-model attitude is responsible for the generation of the course model, in other words the plan of the course. This model represents the mechanism of gross pedagogical content stored in a multimedia database as an elementary fragments, built a hyperdocument (course or learning activity) for a learner who has a particular profile.
The teacher is responsible to define a course plan for every learning style. Altogether, he can customize the plan for sixteen stereotypes that are stored in a library of styles. In the general case, the teacher establishes a default plan that applies to all styles, and afterward he chooses the stereotypes to which he wishes to customize the plan, and that is according to the pedagogical activity. the learners population and number of elementary fragments will be stored in the database. The more the number of fragments is higher, the more the system is flexible allowing adaptation to several learning styles.
The presentation of the course in a web page under a desired format is realized through a CSS style sheet.
The course generator supports the dynamic construction of the course pages from a choice made by the learner, a domain model, a learner model and fragments stored in the database. Then it allows to return at any time the concepts and the links of a page to view it. And so after making a first filter on the fragments in order to select those corresponding to the courses to be taught, a second filter will be applied to select the fragments corresponding to the learning style of the learner and a third one to retain only fragments in accordance adapted with the level of knowledge required (Beginner, Intermediate or Expert). The sub-model “knowledge” of the learner is automatically updated based on the evaluation of the learner after every learning session.
Once the course Builder retrieves the associated plan to the courses for a particular learning style, it looks among the fragments that is most appropriate for each part of the model.

## 6. Conclusion:

In this article we are interested in modeling UML and especially to the static component of our system (class diagrams) of the two facets of the learner model, namely sub-model “attitude” and sub-model “knowledge”, as well as the domain model.
We preferred a modeling by package because of the complexity of the system.
Our system is then composed of four modules:
A domain model that allows modeling the pedagogical knowledge to teach.

A learner model divided in two sub-models: the sub-model "attitude" and sub-model "knowledge", and that allows informing us about the preferences and knowledge level of the learner.
A database to store the elementary fragments.
A Course Generator which allows the construction of the hyperdocument appropriate to the learner according to a definite plan in advance by the teacher.

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