An authoring tool for designing learning scenarios adapted to teachers

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Abstract: - Learning scenario is an important product of the instructional engineering process. It enables to plan learning situations. However, instructional scripting is not *invented* by instructional engineers. It is a common practice for teachers, long time ago, but in a more *intuitive* and *artisanal* way than instructional engineers. Thus, several research projects have focused on this aspect, or how to equip teachers, so they can, like instructional engineers, produce learning scenarios adapted to the current learning problems: use of ICT in classroom, e-learning, etc. A number of tools, fruits of these works, have been created: Exploragraph, ScenEdit or Web Collage. They are called authoring systems. Our research project is a part of these works and aims to create an authoring system providing a support, for designing learning scenarios, adapted to teachers. In this paper, we present a synthesis of our work.

Key-Words: - e-learning, authoring system, learning scenario, educational modeling language, SOA, web service, instructional scripting, instructional engineering.

1 Introduction

The actual boom in information and communications technology (ICT) has significantly changed learning strategies. We tend now to adopt learner-centered learning strategies, which focus on the interests of the student and place the teacher as a facilitator of learning [1]. The learning mode has also seen a major change with the advent of e-learning or distance learning. We can now take courses at home, office, ... where we can make use of a laptop or a smartphone. The learner has also changed. It is no longer the young student provided with school bag, but he may be an employee who wants to complete his vocational training, or a housewife looking for a personal fulfillment through training. The learner became older, nomad, having a professional activity, and family constraints. We can then ask, what about teachers? They are increasingly jostled by ICT and are forced to follow the digital age, without being really prepared. The aim of our work is to support this new generation of teachers, who must juggle classroom and distance courses, and paper and digital content. This through an authoring system adapted to their profile.

In this paper, we start by presenting our research question, and its key concepts: instructional engineering, learning scenario and authoring tool. Then, we introduce a state of the art of authoring systems for instructional scripting. Afterwards, we detail the rich client version of our authoring tool. Then, we construct our scenario model which implements the pedagogy of integration. We end by presenting the web version of our tool, which is a composite application, formed with five web services.

2 Research question

Our research team RIME (Computer Networks Modeling & E-learning or *"Réseaux Informatiques Modélisation & E-learning"* in french), which is part of the research laboratory in computer science and education at Mohammadia Engineering School, is among the first in Morocco to be interested in e-learning [2] [3]. Research works conducted in our team deal with different aspects of distance learning: content production, evaluation, tutoring, etc. Our problematic of research concerns content production, and can be summarized in this question: *"how to help the teacher to create reusable learning scenarios, that he can share with other teachers and can put into practice in the existing e-learning platforms?"*.

Learning scenarios described in text format do not respond to our research question. Indeed, a textual description of a course in physics, for example, cannot be used to plan a course in history.

Also, a scenario in text format, if it is understood by its author, may not be understood by his colleagues. Finally, this type of scenario cannot be played by the existing e-learning platforms, as it does not come in a format supported by these platforms.

Thus, our research work aims to develop an educational modeling language (EML) which is understandable by teachers and adapted to e-learning platforms. This EML cannot be used without a supporting editor that provides assistance, for the task of designing learning scenarios, adapted to teachers. In the last phase of our research project, we adapt our editor in web services, in order to integrate them into our team's e-learning platform, whose architecture is services oriented.

3 Authoring system for instructional scripting

3.1 Instructional engineering

Instructional engineering is the branch of engineering that studies learning systems. More precisely, instructional engineering is *"a method that supports the analysis, the design and the delivery planning of a learning system, integrating the concepts, the processes and the principles of instructional design, software engineering and cognitive engineering"* [4]. Thus, instructional engineering is based on three areas: the software engineering, the cognitive engineering and finally the instructional design. We tend to confuse instructional engineering with instructional design. Berger et al. [5] define instructional design as *"the systematic development of instructional specifications using learning and instructional theory to ensure the quality of instruction. It is the entire process of analysis of learning needs and goals and the development of a delivery system to meet those needs. It includes development of instructional materials and activities; and tryout and evaluation of all instruction and learner activities"*. Instructional design is a process that takes as input the learning objectives and leads to a modelization of the learning system in terms of activities and instructional content. According to these definitions, the two concepts instructional design and instructional engineering are different: the instructional design focuses on the pedagogical aspect in a training project, while instructional engineering is a broader approach that studies the training project from other perspectives than pedagogy. In the center of the instructional engineering process is produced an important artifact: the learning scenario.

3.2 Learning scenario

Known by different names such as: pedagogical sequence, lesson plan or storyboard, the learning scenario has recently acquired a great importance in the computer environment of human learning (C.E.H.L.) research community. It allows describing, for a given learning situation, the learning and the support activities, the roles, the target public, the prerequisites, the objectives, as well as the tools and the resources necessary for the accomplishment of activities [6]. Even if we presented the learning scenario as a product of the instructional engineering process, it is not only made by the instructional engineers. Teachers also create learning scenarios in preparing their courses.

Teachers and instructional engineers, by constructing learning scenarios, aim to better plan learning situations and to improve learner's learning [7] [8].

3.3 Authoring system

An authoring tool is any system that enables creating digital learning systems. It is generally intended to designers, novice in software development, with different levels of knowledge of learning strategies and standards. These systems, user-friendly for the most part, generate rich and attractive instructional contents, playable by the learning management systems (LMSs). We distinguish two main categories of authoring tools: systems for creating instructional contents and systems for instructional scripting. Systems for content creation only spare the user from the technological difficulty, related to the design of digital resources. In these tools, the whole pedagogical difficulty of the design is supported by the user. The tools for scripting, in turn, support the user from a pedagogical perspective: they help to plan courses through learning scenarios, and some of them propose assistance for the design task.

3.4 Authoring systems: state of the art

Despite the growing number of authoring tools available on the web, their adoption, especially by teachers, remains difficult. This can be explained by their use of complicated EMLs like IMS-LD [9] [10], and their non-implementation of a support mechanism for the design task, adapted to teachers [11]. This has led many research laboratories to be

interested in the problematic of instructional scripting, and try to create authoring systems more adapted to teachers. In the following we present some of these tools:

- Genscen' [12], whose main advantage is its user-friendly graphic interface. It is a classroom with all the actors, objects and tools usually present in this room. The terminology used at the interface was determined from a sample of text scenarios written by teachers from rural family houses, and classroom-based courses given in these institutions. Thus, this tool is based on the vocabulary adopted in the rural family houses. It may not be adapted for teachers from other educational institutions.
- REDEEM [13], which is an authoring environment including two applications: authoring tool and intelligent tutor. REDEEM interacts with a catalog of instructional contents and allows the teacher, thanks to its authoring tool, to implement his teaching method on any content of this catalog. This adapted content will be presented to students, by the intelligent tutor, in the way specified by the teacher designer.
- Exploragraph [14], which enables the teacher to create learning scenarios according to the Pleiades formalism. It offers a support mechanism for the design task in four levels. The second level consists on proposing scenario models [15] to implement. This mechanism is very interesting as it resolves many issues related to the instructional scripting. However the lack of an online demo, or screenshots of this mechanism, does not enable us to verify the level of implementation of the support in this tool.
- FLEXO [16], which allows creating two formats of courses: course compatible with Moodle or with IMS-LD format. The course designed for Moodle is not encapsulated in a standard format, but uses various services offered by this LMS: chat, forum, etc.
- ScenEdit [17], which is an authoring tool designed according to the ISiS model (Intentions, Strategies and interactional Situations). The web version currently available enables to create learning scenarios according to a hierarchical tree, divided into steps. It is not possible to export the scenario created, in any format playable by the LMSs.
- Web Collage [18], which allows the creation of learning scenarios for collaborative learning, by composing predefined activity models. Web Collage is limited: in a scenario, we cannot, for example, add activities that do not correspond to the seven activity models proposed by this tool.

These systems are in the early stages; most of them do not generate packages playable by the LMSs, and are based on EMLs, which are not necessarily easier than IMS-LD (e.g. Pleiades formalism). Also, we cannot verify the level of implementation of assistance in these tools, except for ScenEdit and Web Collage whose demo versions are available on the web. We note nonetheless that REDEEM is different than other tools, as it allows the creation of intelligent tutoring systems (ITS). We chose to present it to draw attention to the existence of such tools. A well-known article of Murray [19] deals with the ITS authoring systems.

4 A rich client tool for instructional scripting

In [20] we construct our EML that simplifies and extends the IMS-CP model [21]. We also explain how learning scenarios, created according to our EML, can be exported in IMS-CP packages. To use our EML, we develop a graphic editor of learning scenarios.

4.1 Functional architecture of our authoring system

An EML cannot be used without a supporting editor. So, we create an authoring system that supports the creation of learning scenarios according to our EML. This system is composed by four modules: *design*, *model*, *validation* and *packaging*. The user, thanks to the design module can create a learning scenario from scratch or from a scenario model. Scenario models proposed by our tool are created according to our meta-model [22] and to textual descriptions of different learning strategies. We choose to provide our system with a base of scenario models to support the teacher designer in the task of scripting. The user can use the model module to select a scenario model from this base. He then implements this model to obtain his final learning scenario, which can be used in various

learning situations: face-to-face, blended or online courses. At the end of the scripting process, the user can "pedagogically" validate his scenario with the validation module. This validation may concern a scenario created or not from a scenario model and it is based on a set of best practices in teaching, which we grouped in a repository. After the validation, the user can, thanks to the packaging module, export his scenario in IMS-CP format, in order to play it on the LMSs compatible with this standard. The packaging in IMS-CP format can also be done on not validated scenarios. We summarized in figure 1 the main interactions between the four modules that compose our authoring system:

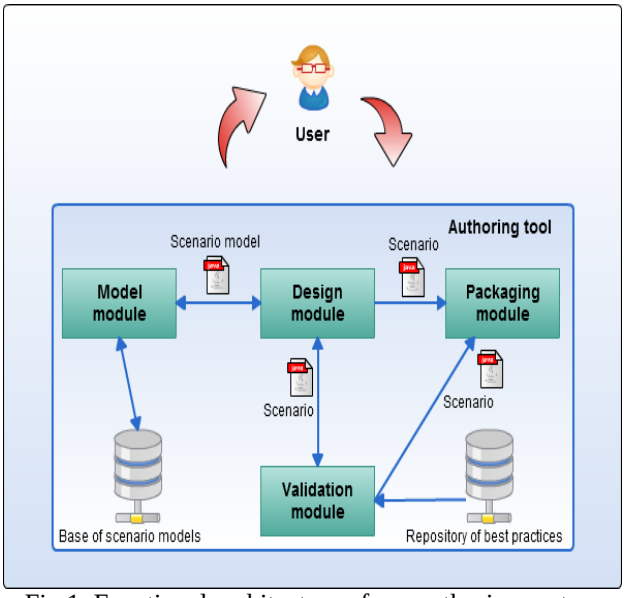

Fig.1. Functional architecture of our authoring system

Our system proposes two important support mechanisms for the design of learning scenarios: the base of scenario models and the pedagogical validation. We used a MySQL database to implement our repository of best practices in teaching. This repository contains rules, formed with the following components:

- The adopted learning strategy
- The learners' learning style
- The targeted skills
- The learners' educational level
- The size of learners group

Each scenario designed with our tool can be analyzed according to these parameters [20].

4.2 Implementation of our tool

For the development of our tool, we chose the GMF [23] eclipse framework, which is a combination of the EMF [24] and the GEF [25] frameworks. EMF facilitates the creation and the implementation of structured models. GEF enables to create rich and interactive graphic editors, using existing models. It is based for the graphic representations on Draw2d framework, itself based on the SWT framework. We chose GMF in order to create an intuitive and scalable graphic editor. Two qualities that we consider important as our tool is intended to non-computer users and our EML can evolve.

Our project consists of three plug-ins:

- **org.eclipse.gmf.test.scenario** is the model part; it involves the definition of all Ecore classes and the models .gmfgraph, .gmftool and .gmfmap. The gmfgraph enables to define all the widgets manipulated in the editor: we distinguish the nodes, the connections and the labels. The gmftool represents the toolbox of the editor, and the gmfmap allows associating the elements of the .Ecore, the .gmfgraph and the .gmftool.
- **org.eclipse.gmf.test.scenario.edit** defines adapters used by the editor.
- **org.eclipse.gmf.test.scenario.diagram** represents the effective graphic editor. All its java classes are generated using the file .gmfgen. However, we can keep the code added to these classes by preceding it by the annotation "@generated NOT".

In our case, we modified all the EditParts of the package org.eclipse.gmf.test.scenario.diagram. Those generated by GMF do not cover all the specifications. Figure 2 represents our Ecore file:

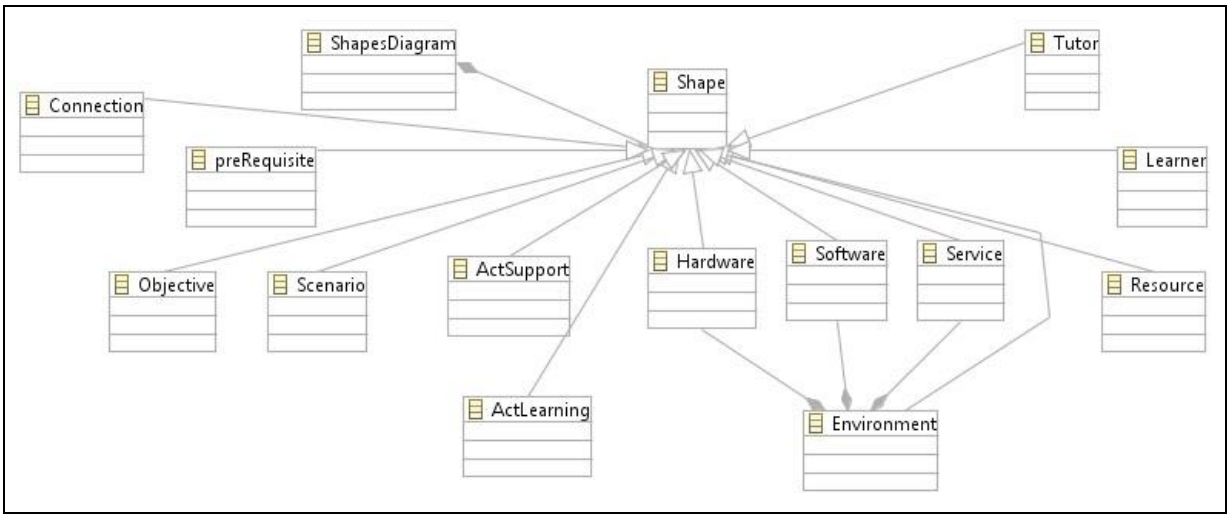

Fig.2. Diagram corresponding to our Ecore file

Our system is composed by an editor, a toolbox and two views: properties and outline. The outline view provides a global view of the scenario under edition and the properties view enables to modify its graphic components.

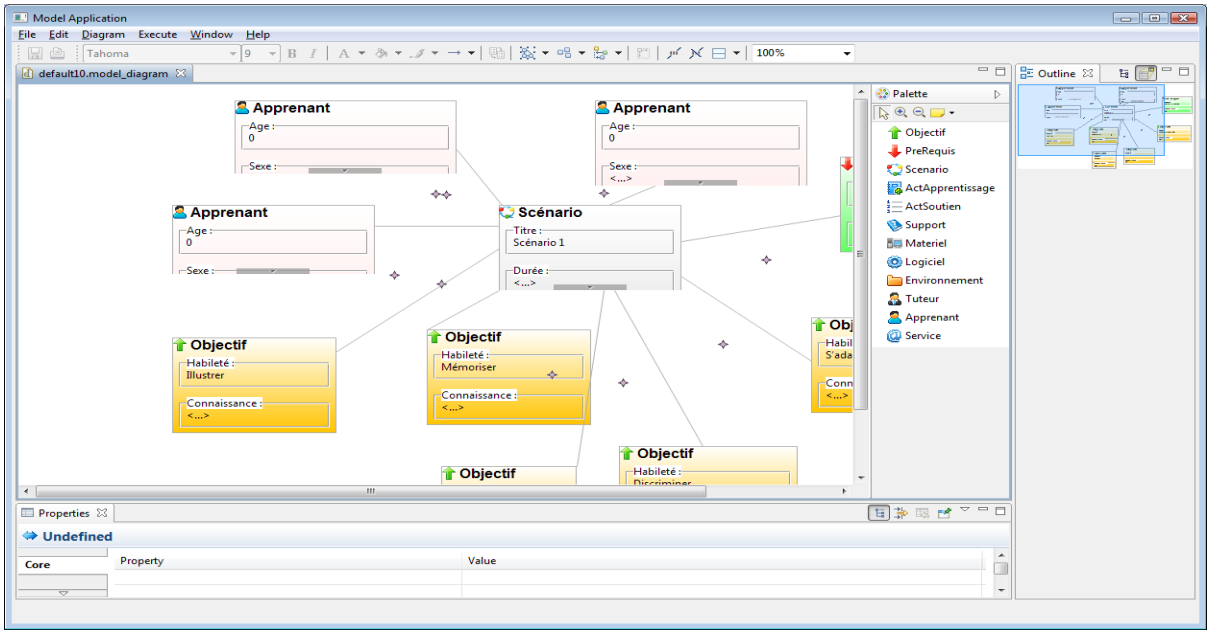

Fig.3. Graphic interface of our tool

Figure 3 represents the graphic interface of our tool. We kept few icons in the toolbox to avoid cognitive overload for users. We also enable resizing graphic components, in order to not cluttering the editor.

5 A scenario model of the pedagogy of integration

5.1 The pedagogy of integration in the Moroccan context

The pedagogy of integration is an application of the approach by competence. It is based on the principle that after a successful completion of a given curriculum, the learner should be able to solve a number of complex situations. It comes as a response to unfair successes and failures that strengthen the student heterogeneity in the class. Success is said to be unfair when it allows a non-competent learner to pass to the following year. Similarly, a failure is characterized as unfair when it concerns a competent learner. Since 2009, the pedagogy of integration has being tested within the Moroccan educational system. It was adopted under

the national contingency plan for the reform of the educational system. It has been subject to much debate among Moroccan teachers. We attempt to provide a look at this pedagogy from a different angle, in order to adapt it for e-learning. This adaptation consists on creating a scenario model of the pedagogy of integration, which takes advantage of ICT, and then we incorporate it into the base of scenario models of our authoring system [20].

5.2 Adaptation of our learning scenario meta-model to the pedagogy of integration

In [26] we analyse in detail the main concepts of the pedagogy of integration in order to match them with the classes of our learning scenario meta-model. In figure 4, we present our learning scenario meta-model adapted to the pedagogy of integration:

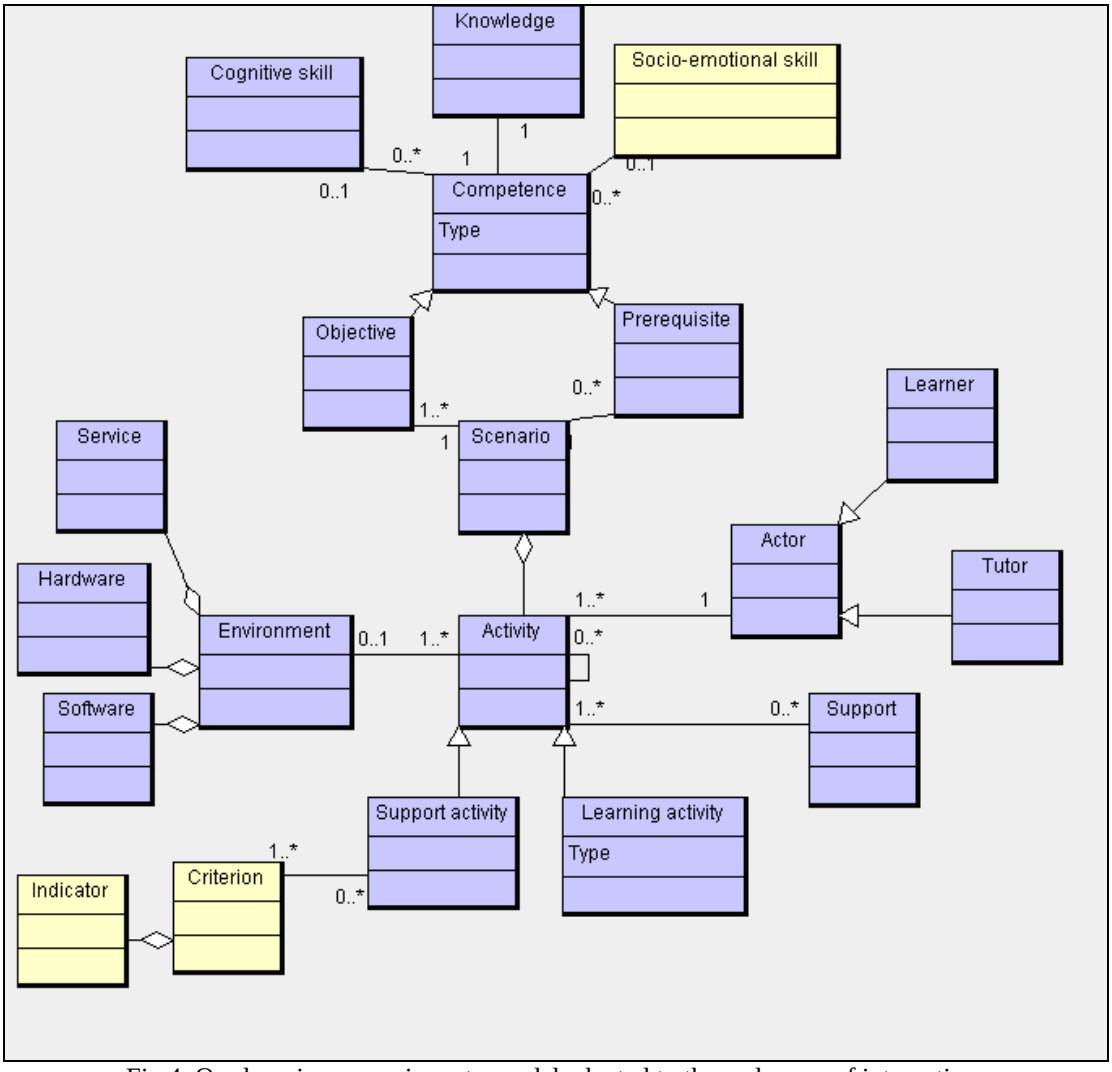

Fig.4. Our learning scenario meta-model adapted to the pedagogy of integration.

We add new classes (yellow ones) to our meta-model to fit the pedagogy of integration. Each scenario is an opportunity to exercise one or more cognitive or socio-emotional competences. These are the objectives of the scenario. The achievement of a scenario may require prerequisites, which are also cognitive or socio-emotional competences. We define cognitive competence as a combination of knowledge and cognitive skill. Concerning the socio-emotional competences, we define them as a set of know-being, or socio-emotional skills, which are involved in the learning situation.

We also distinguish learning activity, from support activity. Support activity is primarily an assessment. It is connected to a number of criteria, by which the learners' work will be assessed. Each criterion can lead to a set of operational indicators. A learning activity may be elementary, integrative or remediation one [26]. The differentiation between these categories of learning activity will be done using the attribute "type" of this class.

5.3 Towards a scenario model of the pedagogy of integration

The implementation of the pedagogy of integration is done according to Roegiers [27] by two methods: in a progressive manner, or at the end of the training period. As Roegiers, we believe that the gradual integration is more interesting from a pedagogical perspective. Indeed, the application of the integration will be more frequent, allowing the learner to get used to this practice. Also, the mass of information to integrate each time will be reduced, so more assimilable.

We begin our scenario model of the pedagogy of integration, by an activity of prerequisites review, after which learners take a formative assessment to ensure that the review was successful. The review activity and the formative assessment can both be conducted online. During the week, the teacher leads face-to-face elementary activities. After each activity, he can provide a formative assessment, as a simple quiz, that will check if this activity is well understood. This assessment can be done online, and refer the student, if unsuccessful, to a remediation activity. At the end of the week, a face-to-face integrative activity must be planned. It aims to show learners the methodology to follow for integrating the elementary learnings acquired during the week. Learners, once home, can work out the integration of learnings, through integrative activities available online. We leave the choice of the frequency of certified assessments to the teacher. We summarize in figure 5 our proposition of a scenario model, implementing the pedagogy of integration, adapted to blended learning:

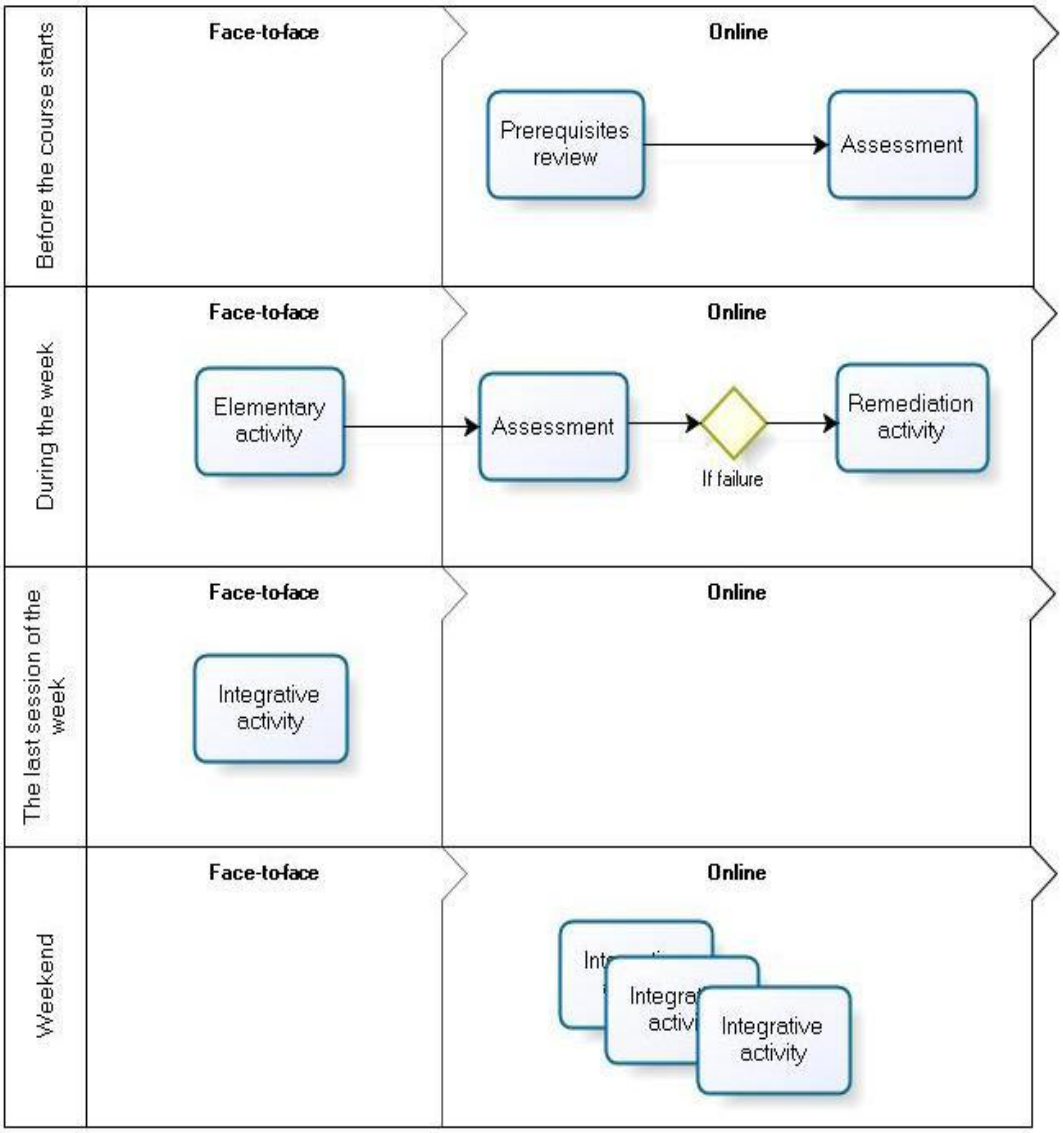

Fig.5. Our proposition of a scenario model implementing the pedagogy of integration.

Now that we have determined the architecture of our scenario model, we must specify what learning strategy to choose for an elementary, integrative, or remediation activity. We propose that a remediation activity must be divided into an elementary activity, where elementary learnings are delivered, and an integrative activity, in which learners will combine these learnings, to solve a complex situation. The elementary activities aim low-level skills such as memorizing, so we can choose for these activities, the lecture or the educational game, as learning strategies. For integrative activities, which need high-level skills like deducing, we can choose the case study or the project as learning strategies. Table 1 shows what learning strategy to choose according to the type of activity:

Tab.1. Learning strategy depending on the type of activity

Activity Type		**Learning strategy**
Remediation activity	Elementary activity	Lecture – Didactic questioning – Concept formation - Debate – Brainstorming - Educational game
	Integrative activity	Concept formation – Investigation - Group discussion – Simulation – Debate – Brainstorming - Case study – Problem solving – Role playing - Project

We have established this table based on our synthesis of best practices in education, which we presented in [20]. For elementary activities, we opted for learning strategies which focus on low-level skills. While we chose the learning strategies that require high-level skills for integrative activities. If a learning strategy is available for the two types of skills (high and low level), we can then use it for all types of activities. This model simplifies the pedagogy of integration for teachers, by demonstrating that it is a combination of learning strategies already known. Finally, we believe that this learning approach is more suitable for blended learning.

6 A composite application for designing learning scenarios

6.1 SOA vision of e-learning platforms

Service Oriented Architecture (SOA) considers the information system as a set of independent and interoperable business services. SOA reduces development costs of new applications by reusing and integrating existing services. We can compare an e-learning platform to an information system of a company, who has to satisfy the same constraints of interoperability and scalability. This is among the issues that have led Khalidi Idrissi et al. [28] to propose a service oriented e-learning platform: it is our team's e-learning platform. In the proposed architecture, they define communication services like chat and forum, and design services for the creation of instructional contents. This architecture is transforming the role of the LMS from a simple player of instructional contents, to a complete learning environment where the teacher can create, integrate and finally monitor his digital courses. The teacher can also use the communication services to contact other teachers. This will encourage them to adhere to the practices of sharing and reuse, which they are not used to [7], and create a community of practice (CoP) around our team's platform, and more especially around our authoring system, as it will represent the design service of this platform. The sharing and reuse practices will save time and effort for teachers, and enable a better capitalization of their experiences. We believe that the CoP approach is the best way to facilitate the adoption of our authoring system by teachers. Indeed, the teacher will find in the community a support adapted to his profile, and scenario models already tested and validated by his colleagues [29]. Thus, we adapt our authoring system in web services in order to integrate them into our team's e-learning platform.

6.2 SOA architecture for our authoring tool

The first version of our authoring system is a rich client, developed with the GMF eclipse framework. We share our team's vision of an elearning platform that supports the teacher designer during the design, the integration, and the monitoring of his digital courses. The adopted architecture for this platform is service oriented. Therefore, we convert our authoring system to a composite application *"authoring service"* created by orchestrating five web services: *design service, model service, validation service, packaging service and rule service* [fig. 6].

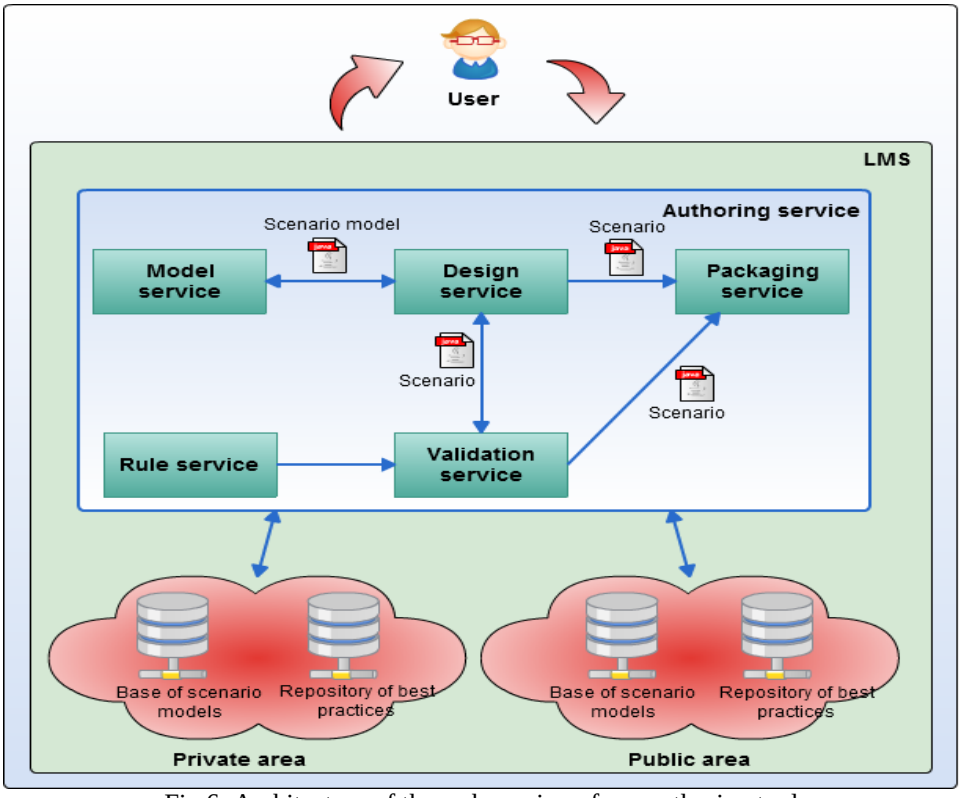

Fig.6. Architecture of the web version of our authoring tool

We open our authoring system to the users: they can supply the bases of scenario models, and enrich the system with best practices in teaching. We prefer to distinguish between the private area of each user, and the public area shared by all the users. Each user has his own base of models and his own repository of best practices in teaching. The user can create a scenario model that he may share or not with the other users. To make his model available for the other members, the user must publish it in the public base of models. Once the creation of a learning scenario is completed, the user can validate it according to his own repository of best practices in teaching. This repository is provided with the rules created by the user himself, through the rule service, or with rules imported from the public repository. This allows the user to have a full control on the validation process.

6.3 Description of web services composing our system

We prefer to use the design view to present the WSDL [30] file of the web services composing our system. The source view is less readable. Our authoring service is a composite application formed with five web services: design service, model service, validation service, rule service and finally packaging service [fig. 7].

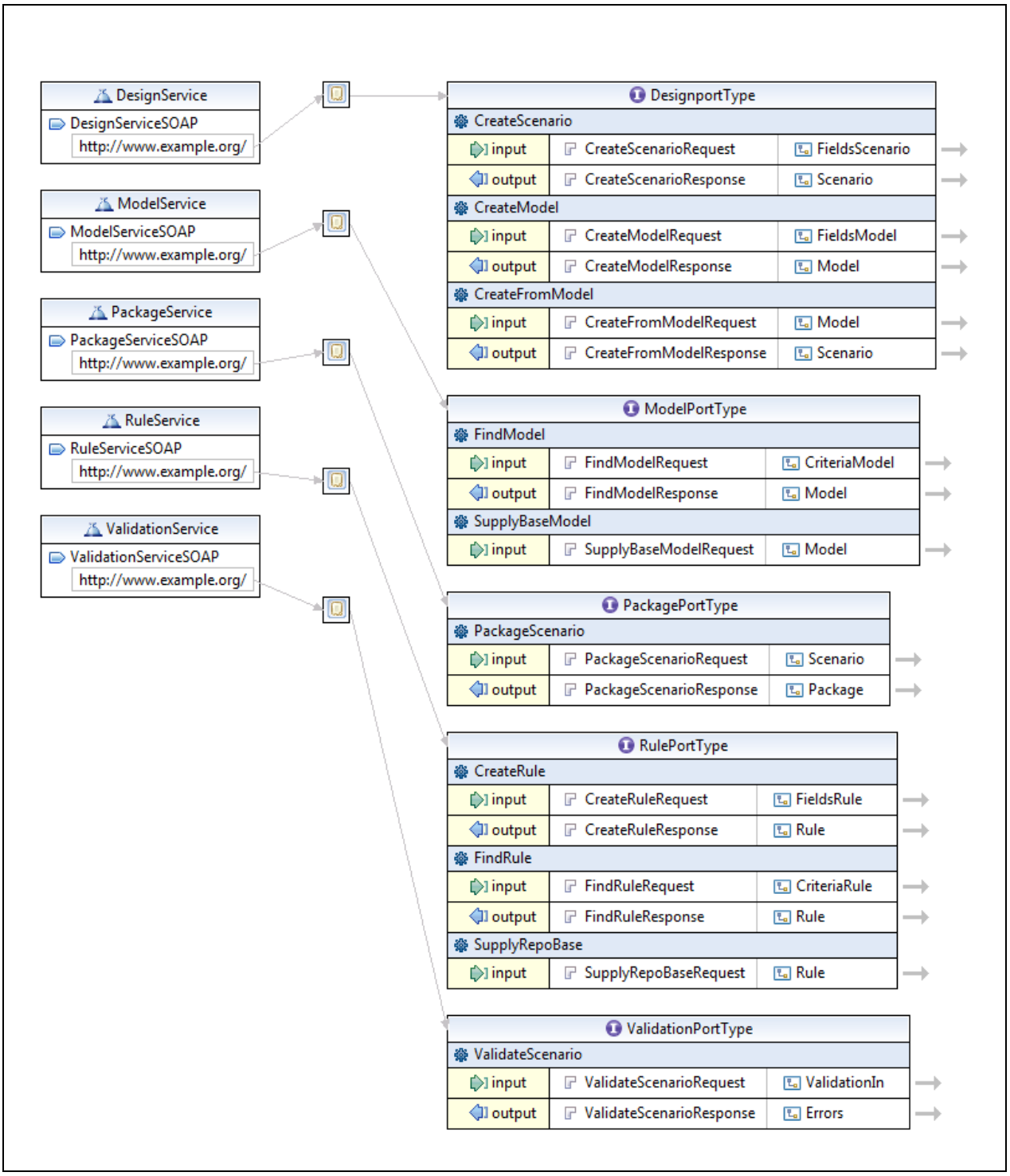

Fig.7. Description of web services composing our system

- **Model service:** It can be considered as the entry point to the model bases. This web service queries the model bases (public or private), according to the user's response to a questionnaire (CriteriaModel), to find the scenario model, which is closest to the user's request. It also supplies the model bases with models created with the design service.
- **Packaging service:** This web service allows packaging the scenarios created with our system in a format playable by most of the LMS: IMS-CP.
- **Rule service:** This web service enables to create rules (CreateRule), supply the public and the private repositories of best practices in teaching (SupplyRepo) and finally find a rule that meets certain criteria (FindRule).

Rules concern the components previously presented.

- **Validation service:** It enables to validate a learning scenario according to the private repository of best practices in teaching, and following the method presented in [20]. Inconsistencies between a scenario and the rules of the private repository are displayed to the user. The object 'ValidationIn" is formed with the scenario to validate, and an extraction of the private repository.

6.4 Design service

This is the main web service of our application. It enables to create learning scenario models (CreateModel), and learning scenarios from scratch (CreateScenario), or from a scenario model (CreateFromModel). For the implementation of this web service, we choose to reuse the existing editor, developed with the GMF eclipse framework. In order to convert our editor to a web application, we use the RAP eclipse framework [31]. RAP aims to enable software developers to build Ajax-enabled rich Internet applications that need both desktop-based and web-based front ends. We obtain a web application by modifying the source code of the existent rich client tool. In figure 8 we test the creation of a learning scenario with the web editor:

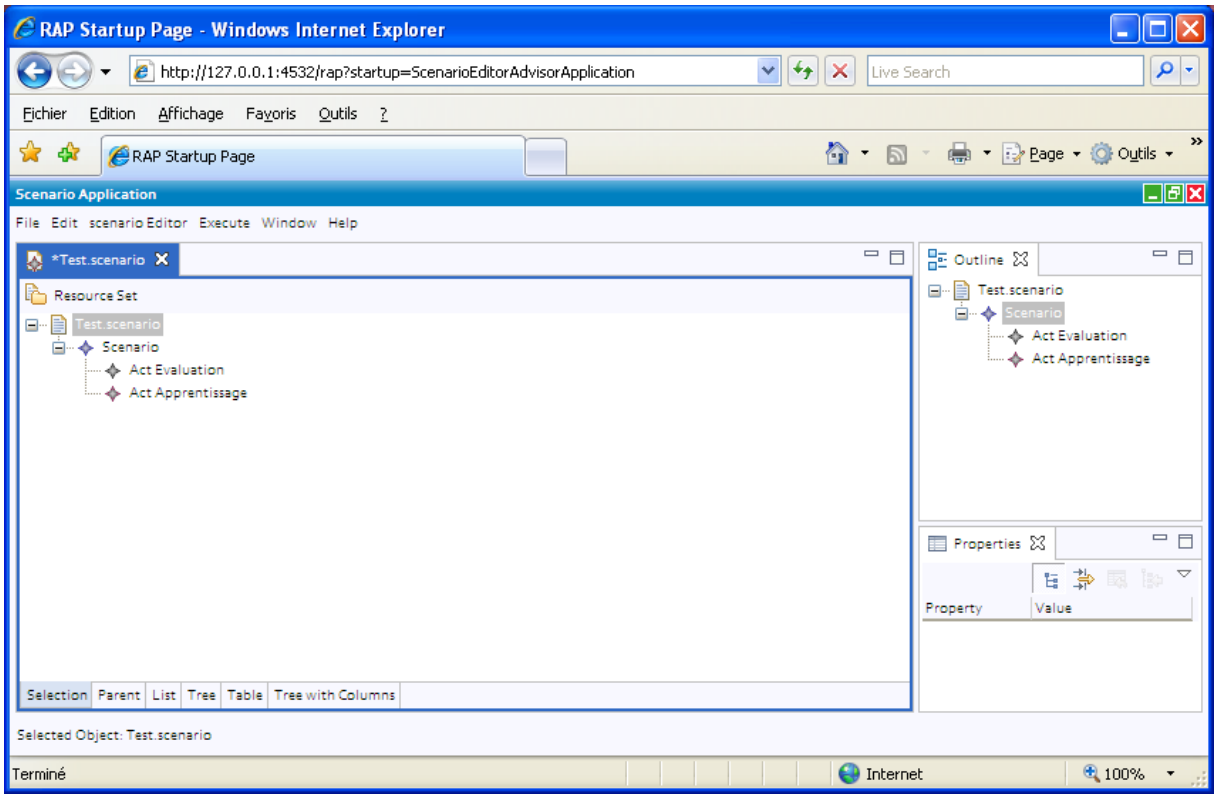

Fig.8. The web version of our authoring tool

The graphic interface of the web editor still needs some improvement, especially at the structure of the learning scenario, which is a hierarchical tree.

6.5 Authoring process

In this process, we use all the features offered by the web services presented above. We start by creating a learning scenario from a model. Then, we validate it according to a set of rules. Finally, we export the validated scenario in IMS-CP package [fig. 9].

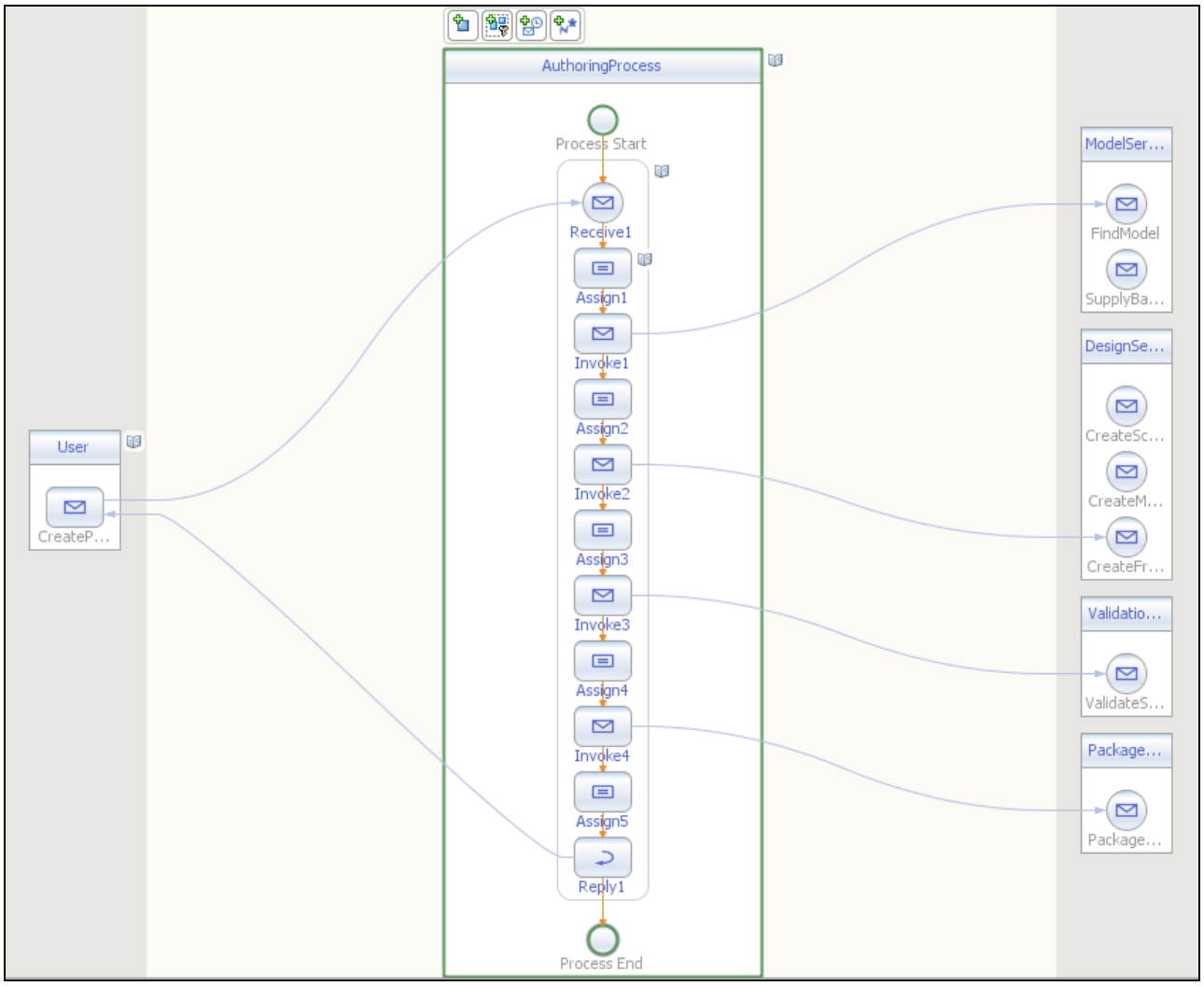

Fig.9. Authoring process

The process, represented in BPEL [32], begins by receiving the user's response to a questionnaire. Following this response, the model service, and more precisely the operation "FindModel", queries the model bases (public or private) to return to the user the model that best matches his request. This model is then instantiated with the operation "CreateFromModel" of the design service. It is now a learning scenario that the user implements, then validates using the validation service. Finally, the user exports the validated scenario in IMS-CP package, thanks to the packaging service.

7 Conclusion

The aim of our research is to support teachers in creating learning scenarios. For that purpose, we start by developing a rich client editor of learning scenarios. Our editor proposes two important support mechanisms for the task of scripting: the pedagogical validation and the base of scenario models. We supply this base by a scenario model of the pedagogy of integration. This model is adapted for blended learning. Finally, we adapt our editor for the web in order to integrate it in our team's platform. The web version of our tool is a composite application based on five web services: design, model, validation, rule and packaging.

We can divide the advantages of our work in two parts:

- For our laboratory: the web version of our authoring tool represents the design service of our team's e-learning platform. It is the main service of our platform as it represents the starting point of the digital courses creation process.
- For the teacher: As seen in the state of the art, existing authoring tools are not adapted to teachers as they are based on complicated EML, don't offer a sufficient support to design task and don't enable to export the created scenarios in a format playable by the LMSs. we expect that our tool will help the

teacher to better plan his courses, as our EML takes into consideration the main components of learning situations. Also, our tool proposes a support for the design task adapted to the teacher: the pedagogical validation and learning scenarios already tested and validated by his colleagues. Finally, our tool enables to package learning scenarios in IMS-CP format which is playable by most of e-learning platforms.

We expect that a group of teachers, from different specialties, can test our system. But, we need first to improve our web editor. The objective is to have the same graphic interface and features in the both versions of our system: web and rich client. We have also to supply our system with more scenario models. We presented in this paper our scenario model of the pedagogy of integration, adapted to the blended learning. We are working to model other learning strategies [33].

Our research project enables us to better understand issues and challenges of e-learning. It is also an opportunity to become familiar with the teaching profession, which is more and more complex and requiring multidisciplinary competencies.

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