Applicability of Use-Case Modeling for Virtual Learning Environments

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Abstract: *In this paper it will be explained what use-case modeling really is. A brief introduction to RUP, UML and use-case modeling will be given. The paper focuses on the applicability of use-case modeling for virtual learning environments. The use-case modelling process will be explained and put in the context of the VLE specific organization. Some examples of use-case diagrams for five different user types of virtual learning environments are proposed.*

Key words: *use case, use-case modelling, UML, Virtual Learning Environments, Virtual University*

INTRODUCTION

One of the biggest problems in constructing models of virtual learning environments is how to decide and specify what is going to build, and why. Poor understanding of target user needs, ineffective use of limited resources, wrong design priorities – all will contribute to inappropriate models of virtual learning environments.

Many software engineers recommend IBM Rational Unified Process (RUP) [5] as a software engineering process that comprises many software development best practices. RUP advocates using use-case modeling to capture the operational requirements of a software system.

Use-case modeling is a useful modeling technique that provides a simple way to understand and describe the behavior of the system: what the system will do and who will use it. There is a whole variety of ways different authors recommend to write use cases, [4]. UML includes a use case concept as well. Unified Modeling Language (UML) is adopted by the Object Management Group (OMG) as a standard in 1997 [5]. One of the purposes of UML was to provide the development community with a stable and common design language that could be used to model computer applications. Now UML 2.0 is a unified standard modeling notation that IT professionals use to read and disseminate system structure and design plans, [6].

LAYOUT

The paper focuses on the applicability of use-case modelling for virtual learning environments. The use-case modelling process will be explained and put in the context of the specific organization of virtual learning environments.

In the beginning, some basic concepts in use-case modeling will be given, [2].

The use-case model includes two components: actors and use cases. A use cases describes a sequence of actions that provide something of measurable value to an actor. OMG's UML 2.0 standard defines a graphical notation for use cases, where use cases are drawn as horizontal ellipses. A simple VLE system could make use of the following use cases: enroll students in courses, input student course marks and etc.

Actors represent the people or things that interact in some way with the system. Actors have a name and they are associated with the use cases with which they interact. Actors are drawn as stick figures. The set of all actors and use cases describing the system are known as use-case model.

Use-case models can be depicted using use-case diagrams. Use-case diagrams are visual maps of all user-functionality. Associations between actors and use cases are indicated in use case diagrams by lines, with an optional arrowhead on one end of the line. The arrowhead is often used to indicating the direction of the relationship. According to OMG UML 2.0 graphical notation use-case diagrams have three types of relationships, [6]:

- Include - An Includes relationship is used to indicate that a particular use case must include another use case to perform its function alternatively. It is drawn as a dashed line with an open arrow head and along the line somewhere is placed "<<include>>", surrounded in guillemets;

- Extend - An extend relationship indicates that the use case depends on the behavior of the base use case and may optionally add the execution of its events to it. It is drawn as a dashed line with an open arrow with the text "<<extend>>";

- Generalization – A generalization relationship denoting the inclusion of the behavior described by a use case within another use case. Generalization is depicted as a line with a close-headed arrow.

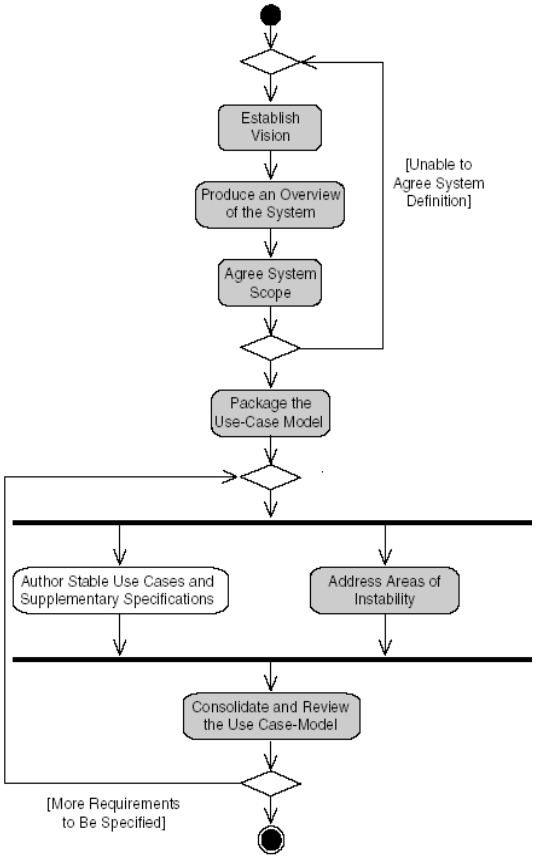

Fig. 1. The Use-Case modeling process

It is important to distinguish between the use-case model and the set of diagrams of a system. A diagram is a partial graphical representation. Use-case models contain diagrams and also a "semantic backplane" — textual documentation such as written use cases that explain the model elements and diagrams. On the figure 1 Use-case modeling process is presented. It is composed of several steps in RUP, which illustrate the activities involved in the development of a use-case model, [2].

The use-case modelling process will be explained and put in the context of virtual learning environments.

Establishing the Vision - The first step is to identifying stakeholder (actor) types. That can be for example a set of users, or people from the development team, sharing the same characteristics and relationships with the system. The stakeholders in the virtual learning environments (VLE) are usually – students, teachers and administrators. Depending on the type of VLE the number of stakeholder types is different, see Table 1.

Table 1. Stakeholder(Actor) types for VLE

Virtual learning environment	**Stakeholder (Actors) types**
Web-based course	Students (Guests) , Teachers
Virtual Center for E-learning	Students (Guests), Teachers, Administrators
Virtual University	Guest, Students, Teachers, Learning Administrators, System Administrators, etc.

When the virtual learning environment has a free access to it's learning resources - Students and Guests have the same rights, characteristics and relationships with the system. In that case Web-based course may have two stakeholder types – Students (or you can call them Guests) and Teachers.

The next step is to define the stakeholders' roles and responsibilities in the system. For example, for a virtual university can be defined five stakeholder types, see Table 1. Within those five stakeholder types users have assigned roles. The roles and responsibilities for every type will not be given in detail. In Table 2 they are summarized some of the roles, determined by used access method (read, write, or edit). More about the stakeholder roles, the responsibilities that they are taking on, the level of involvement they will be required to provide, and who will act as the primary source of requirements, find in the use-case diagrams (Fig.2, Fig.3, Fig.4, Fig.5 and Fig.6).

Table 2. Relating Stakeholder Types to Virtual University Resources

			VIRTUAL UNIVERSITY STAKEHOLDER TYPES				
		rights	Guests	Students	Teachers	Learning administrators	System administrators
VIRTUAL UNIVERSITY RESOURSES	Science fields	R	X	X	X	X	X
		W (E)				X	X
	Professional directions	R	X	X	X	X	X
		W (E)				X	X
	Speciality	R	X	X	X	X	X
		W (E)				X	X
	Curricula	R	X	X	X	X	X
		W (E)				X	X
	Learning programs	R	X	X	X	X	X
		W (E)				X	X
	Virtual library	R		X	X		X
		W (E)			X		X
	Portfolios	R	X	X	X	X	X
		W (E)		X	X	X	X
	Accounts	R			X	X	X
		W (E)					X
	Messages	R		X	X	X	X
		W (E)		X	X	X	X
	Forums	R		X	X		X
		W (E)		X	X		X
	Chat	R		X	X	X	X
		W (E)		X	X	X	X
	News	R	X	X	X	X	X
		W (E)					X
	Calendar	R		X	X		X
		W (E)		X	X		X
	Help information	R	X	X	X	X	X
		W (E)					X

R – read;W (E) – write (edit).

A best way to establish the vision is to understand the user needs. Effectively solving any complex problem involves satisfying the needs of a diverse group of stakeholders. Typically, stakeholders will have different perspectives on the problem and different needs that must be addressed by the solution. Students and teacher in the VLEs have different needs. Concerning the teachers, VLEs have to be a virtual center for creating and developing educational courses, and concerning the students, VLEs is a virtual library with learning materials.

The stage "Establish the vision" finishes with the Vision document. The Vision document is the Rational Unified Process artifact that captures all of the system requirements information that has been discussed.

Produce an Overview of the System: This section provides a high-level view of the capabilities, assumptions, dependencies (interfaces to other applications), and alternatives to the development of the product. At this stage, there is no need to fully detail system functionality, only the basic characteristics of the system have to be specified. Concerning VLE, at this stage for example, there is a need to specify what will be the access to the learning resources in the system: control access or free access. Other system characteristics, such as E-learning platform type, Database usage, and etc., are also important to produce overview of VLE system.

Agree System Scope: The process of designing system scope is very important in use case modeling. The system scope is the set of systems, hardware and software, that have to be used in designing. To manage scope effectively, we have to define what the

system must contain and what optional features would be good to have. If we are going to design a VLE, we have to use hardware and software, which is appropriate for web-based application.

More detail information about these two stages in the context of VLE and about the system parameters of VLE read in [3].

The use-case modeling process is not linear as the figure 1 may imply. For example before the stage "Package the Use-Case Model" there is need of an agreement that a single use case is in the system scope.

Package the Use-Case Model: The packages are used as a mechanism for organizing elements and the structure of the use-case model. A package may contain a number of actors, use cases, use-case diagrams and etc. On Fig.2, Fig.3, Fig.4, Fig.5, and Fig.6, a full range of use-case diagrams for Virtual University system is proposed.

The use-case modeling process continues with two parallel activities: **Address Areas of Instability** and **Author Stable Use Case and Supplementary Specifications**. Supplementary Specification is a requirements artifact in the RUP. It is a document that captures the system requirements and the functional aspects of the system, which are neither visible to the system's actors, nor local to a specific use case.

Following the Use-Case modelling process, a complete use-case model for users' interactions in a Virtual University system has been created. There will be given some elements from that model: an example for a use-case specification and some examples for use-case diagrams, Fig. 2, Fig. 3, Fig. 4, Fig. 5 and Fig. 6.

Use-case specification "Enrolment procedure for new students in the VU" (Brief version)

1. *Brief Description*: This use case describes how a Guest user uses the Virtual University and how he follows the enrolment procedure for new VU students.

2. *Use-Case diagram*, see Fig.2.

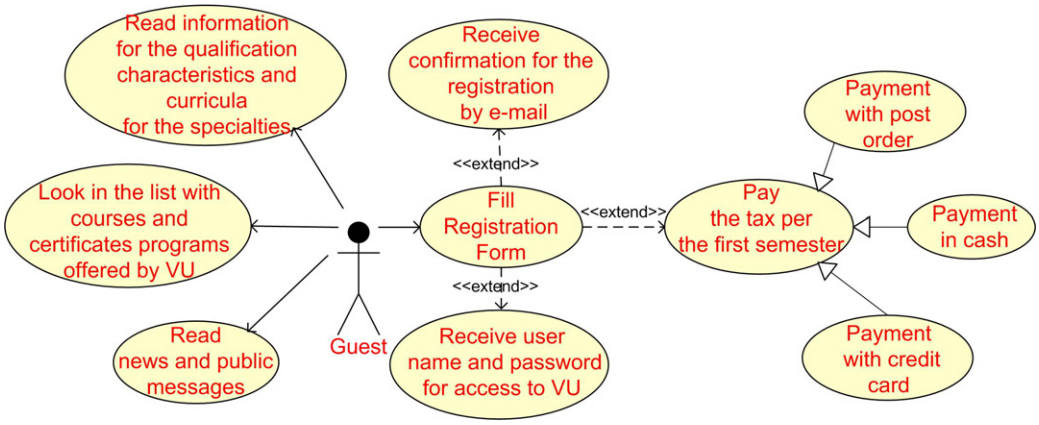

Fig. 2. Use-Case diagram for Guest interactions in the VU

3. *Preconditions*

- The Internet connection to the VU must be active;
- The SMTP services must be available.

4. *Basic Flow:*

1) The use case begins when the user visit the VU web address.

2) Guest user read all public information that is currently available on the web site.

3) Guest user fill the registration form.

4) The guest pay the tax per semester.

5. *Alternative Flows*

- {If the form is filled correctly}: The system sends an e-mail to confirm the registration.
- {If the tax is paid}: The system sends an e-mail with the username and password.

6. *Subflows*

- The system checks to see if the compulsory elements of the application form are filled.
- The system also determines whether all the elements of the form are filled correctly.

7. *Post conditions*

- The system has returned error and message with explanation which element is not filled or is not filled correctly.

8. *Special requirements*

None.

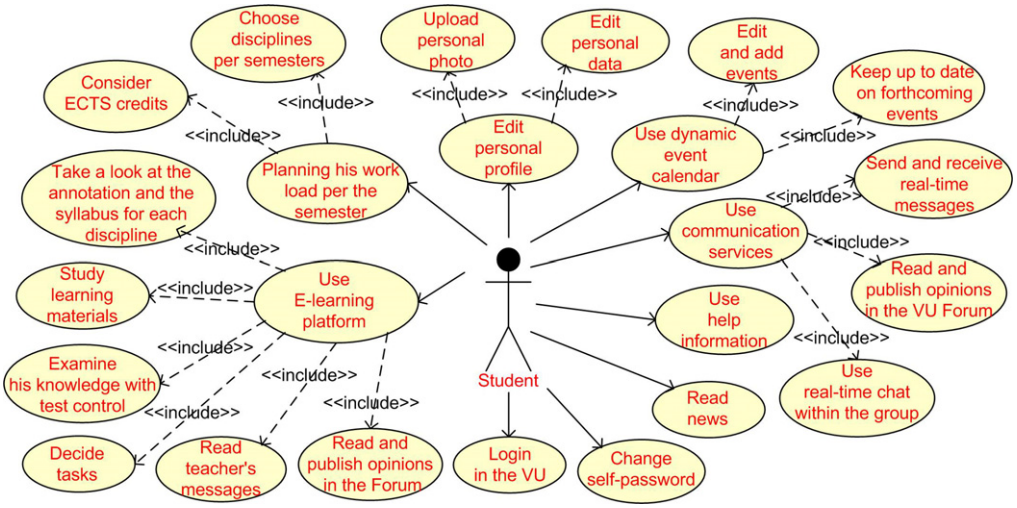

Fig. 3. Use-Case diagram for Student interactions in the VU

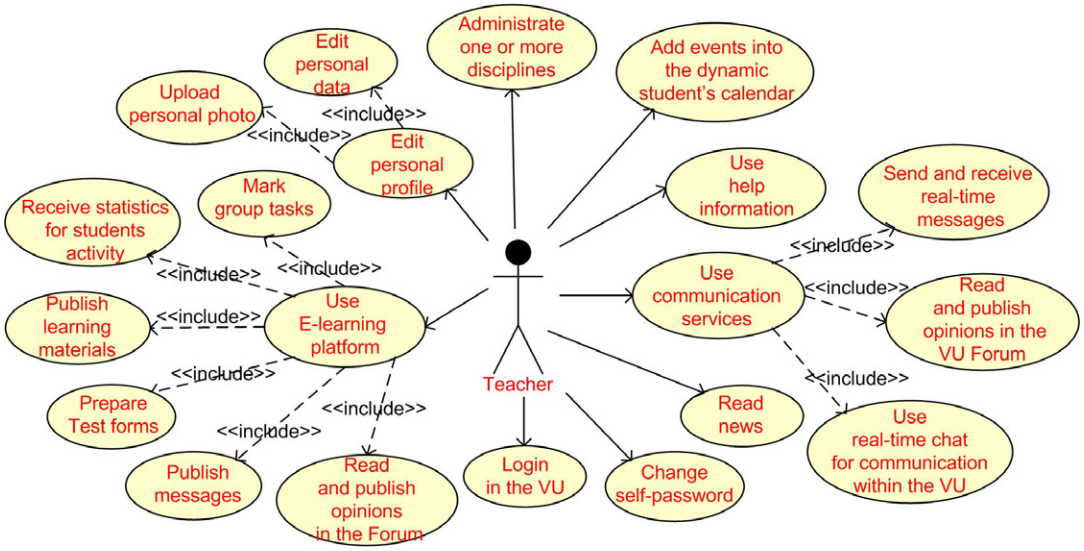

Fig. 4. Use-Case diagram for Teacher interactions in the VU

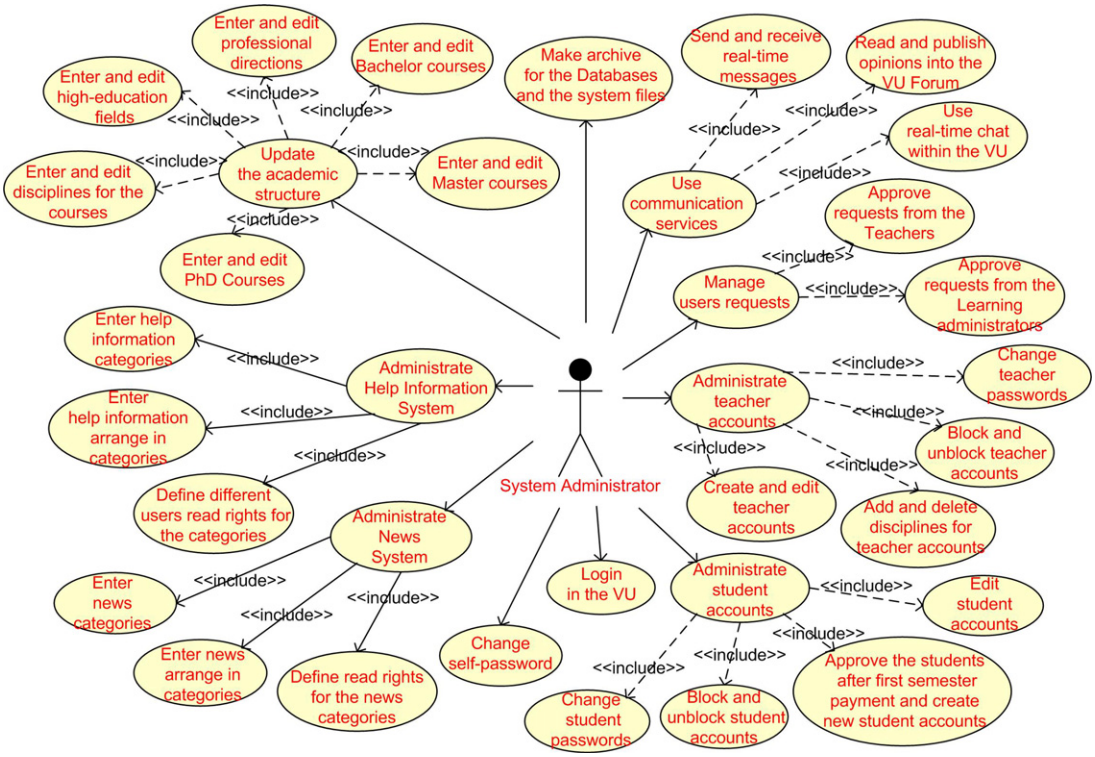

Fig. 5. Use-Case diagram for System Administrator interactions in the VU

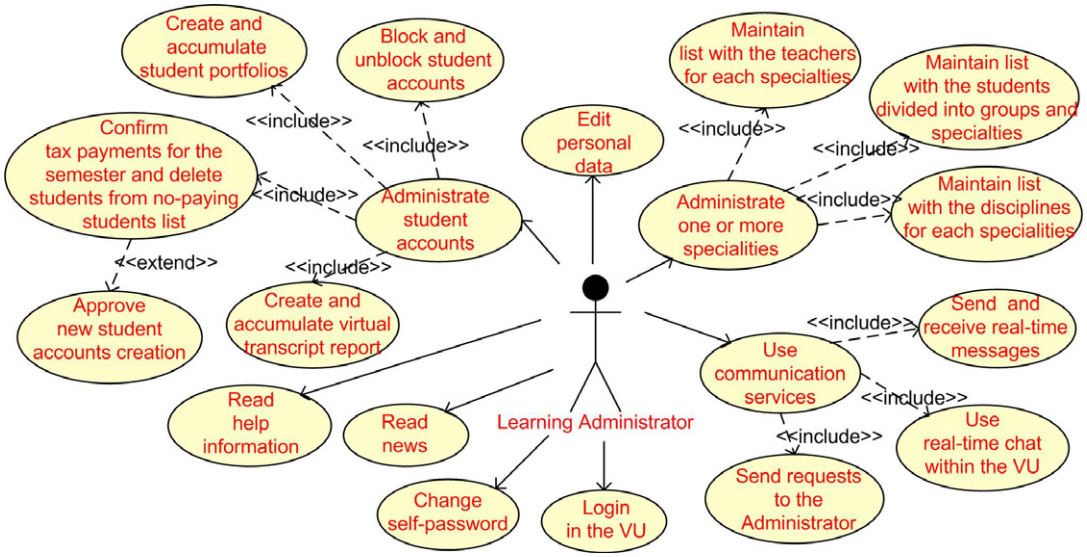

Fig. 6. Use-Case diagram for Learning Administrator interactions in the VU

As you see VU administration is divided between Teacher (responsible for creating and developing educational courses), Learning Administrator (responsible for planning, organizing and control the learning activities within the specialty) and System Administrator(responsible for the whole system). The Learning Administrator is responsible also for all important documents and reports collection. He has one of the most important roles in the VU and his functions have to be well-planned. A best approach for a Module for planning, organizing and control the learning process in a VU is shown in [1].

CONCLUSION

An approach for applicability of use-case modeling in the context of VLE have been presented. This paper not only provides idea of what use-case modeling is but how it can be utilized in a real development project – Virtual University. VU use-case models are the foundation to the understanding of the VU system.

Future work

In UML 2.0 there are 13 types of diagrams and they can be used to form a compete system model for a virtual learning environment. Use-case diagrams for example are used in the Functional Model. There are other two parts of the system model: Object Model (Includes Class Diagrams - the structure and substructure of the system using objects and associations) and Dynamic Model (Includes Sequence Diagrams, Activity Diagrams and State Diagrams - the internal behavior of the system).

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